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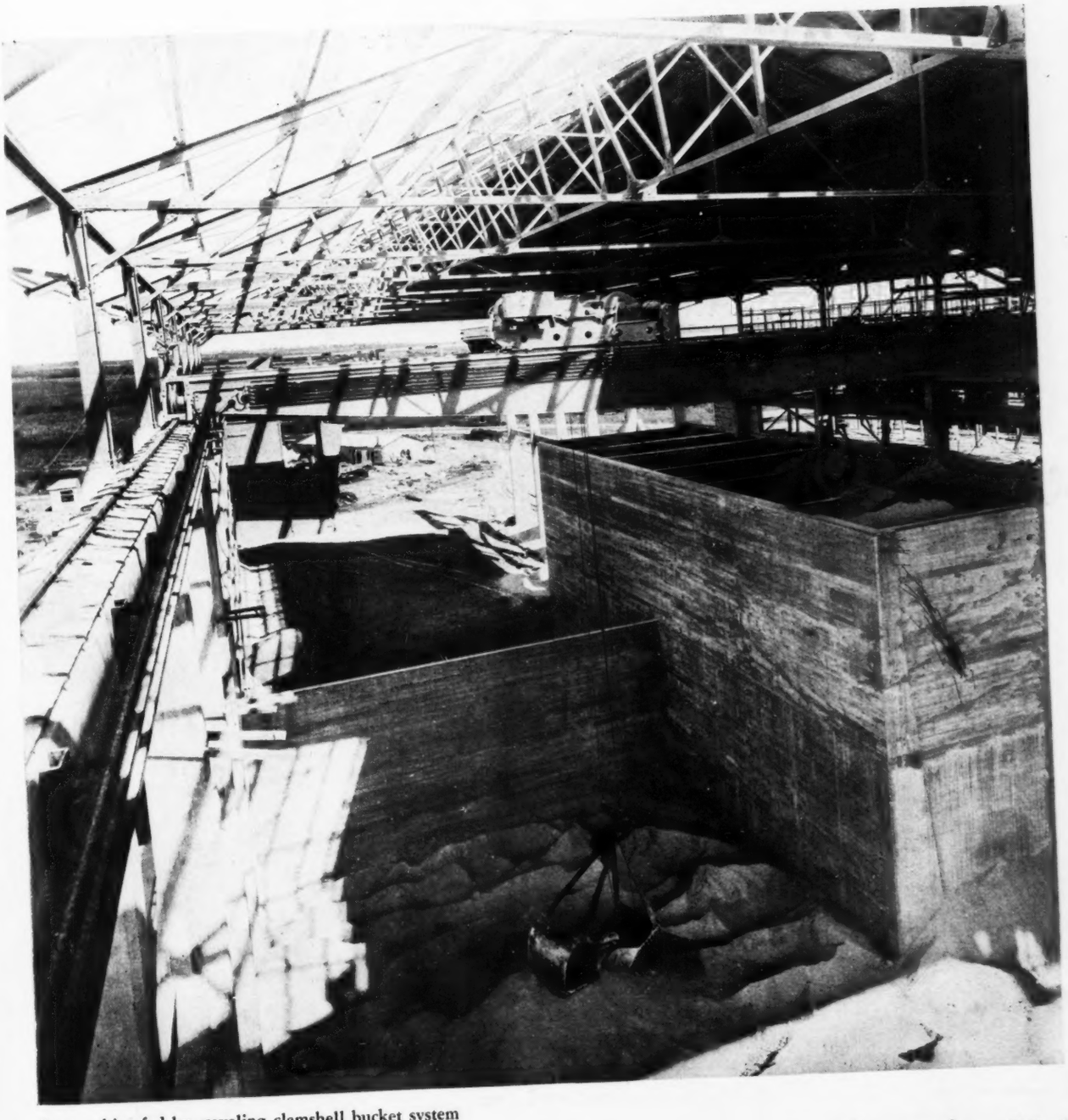

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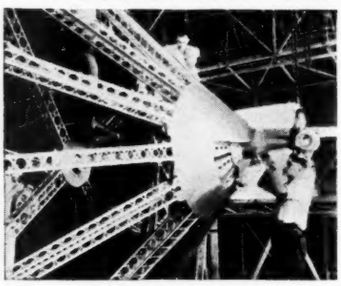

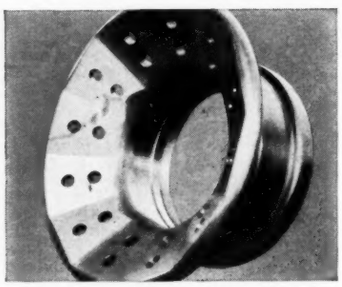

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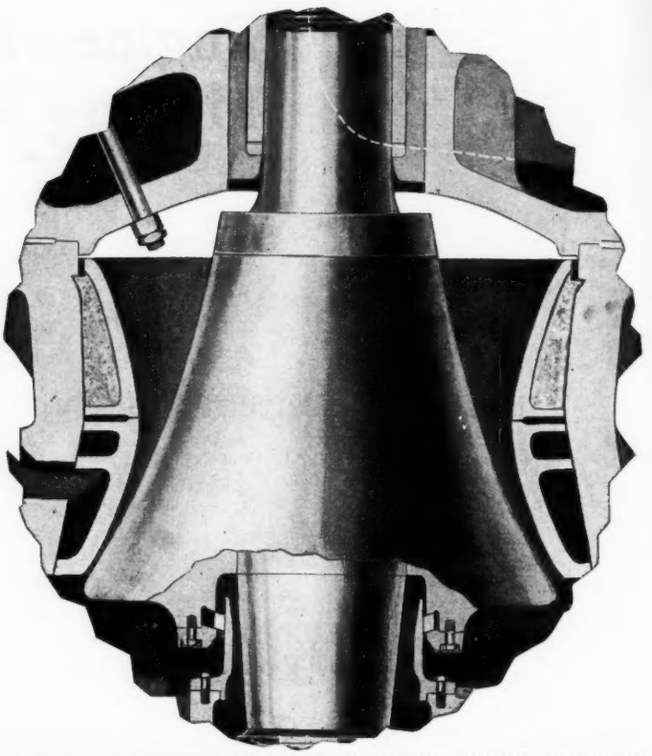

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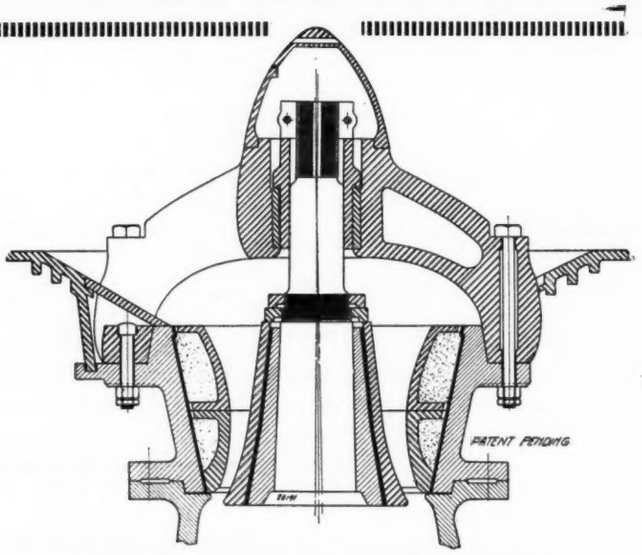

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Engineering and Mining Journal

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November 23, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 10

Unemployment, a Challenge to Education

ONE of our contributors, a master mechanic at a distant mining property, makes the following interesting statement in a recent letter: "My work here is very light, and to pass time away I often seat myself near some part of the plant and wonder and speculate if some change could be made to better economy or improve operation. The management has been very sympathetic to my wild schemes, which in some cases have turned out to be profitable." Not always is such interest in the behalf of their employers displayed by those whose time rests heavy on their hands. The fact that the suggestions offered fall upon receptive ears indicates that the fruitful cooperation between employee and management is not coincidental.

Continuing along this line of reasoning, a thoughtful observer cannot fail to realize what a challenge the present situation holds out to educators. This does not refer to our institutions of learning only, where a heavy influx of students and post-graduates has to be taken care of, but also to our industrial leaders. One of the remarkable trends in industry is the growing tendency to assume teaching responsibilities, not in competition with legitimate educational institutions, but as supplementing their work to furnish instruction too specific in nature to include in the curricula of the regular schools, and to make acquisition of knowledge possible to many who, because of age or financial limitations, would otherwise be deprived of intellectual progress. Such training includes safety and first-aid instruction, shop work, training courses for apprentices and foremen, instruction in the fundamentals of the science involved in the specific operation, laboratory work, and courses in management for executives and subordinate members of the staff. The steady growth of these activities, in spite of frequent difficulties in crowding the work into the hustle and bustle of a busy organization operating at capacity, is clear evidence that their value is fully appreciated.

With the approaching winter holding the prospect of curtailment and reduced working hours, development of this character should be increased. Idleness is stagnation, if not retrogression: a negative force, leaving its victims in a worse state than it found them. Nothing should be left undone to mitigate its effects. In mining communities, where recreational and educational facilities are usually less diversified than they are in the larger cities, special efforts are needed in behalf of those partly or totally unemployed, to help them through the long days of waiting. Educational activities already in existence should be maintained and extended. Arrangements should be made to get maximum efficiency from clubs and libraries serving as centers for these activities. Staff members who are able to do so should be encouraged to give part of their time to this work. Executives with sufficient vision to grasp the opportunities presented can find no better way to build for future progress.

More Canadian Mining Wonders

TWO MONTHS AGO, in these pages, Mr. C. M. Campbell pointed out that Canada was not wholly a land of milk and honey, or rather precious and base metals, but that only certain very limited parts of it were so blessed by Providence. He deplored the stories of fabulous riches that enliven the pages of our newspapers. Unfortunately, however, the editor of the New York *World-Telegram* apparently missed Mr. Campbell's article, for we see in the October 27 issue a three-column head stating that "Thirty-Inch Veins of Silver and Huge Deposits of Pitchblende Found in Arctic Circle Wastes." The story, written by "Leonard Rogers, *World-Telegram* Financial Writer," hits the reader right in the face with this opening paragraph: "Metallic silver lying in 30-inch veins and deposits of massive pitchblende shot through with silver leaf and films! It's a bonanza! Nothing like it was ever seen before in the history of North American mining!"

It must even surpass the enormous riches the newspapers uncovered in Weepah, Nevada, two or three years ago. And this has films with it too, presumably making importations from Hollywood entirely unnecessary. The silver leaf will probably be used to roof the igloos, no gold leaf being available there as yet.

Mr. Rogers says he got the story from E. E. Campbell, a veteran mining engineer and rugged Northerner, though details of the party at which these gentlemen appear to have been present are lacking. Mr. Campbell (not Mr. C. M. Campbell) admitted, says Mr. Rogers, "I haven't seen it yet with my own eyes, but two of my men have been up there and we have some claims staked out. The new find is exactly on the Arctic Circle, Yellowknife Preserve, District of Mackenzie, in the Canadian Northwest."

The men who are staying there this winter will battle "the intense cold with fires made from logs conveyed to the camp by aërial express last summer at a cost of $25 a log." These hardy pioneers, who "will live in igloos, catching a brief glimpse of the sun each midnight," are no doubt kept there to guard the treasure. Every night, when the sun comes up momentarily, they will peer out of the door of their igloo and see if the massive pitchblende, silver leaf, and films are still there!

Planning Without Insurance Provision Is Futile

A POLITICAL philosophy that exerted a major influence among the great bulk of the population a few years ago proclaimed a perpetual prosperity. The rank and file were hypnotized into spending all they earned as fast as received, and urged to mortgage credit to the limit. Provision made for insurance against survival was pitifully inadequate, as events have since proved, partly because so many people believed that statesmanship and political sagacity could be relied upon to insure an indefinite continuation of a condition of physical luxury, partly because the obtaining of security by insurance was a costly and complicated business.

One state, Massachusetts, as we mentioned before in these columns, pioneered in reducing these disabilities, by permitting savings banks to sell life or annuity insurance, unencumbered by the usual expense of solicitation or the charges for subsidiary activities normally paid for by the policy holder, or deducted from the returns to which he is entitled. An example of what is usually excused as enlightened selfishness on the part of an insurance company is a booklet, recently issued, that explains the functions of an assistant to the president of a corporation—one of a series on business organization. Such a pamphlet is of no possible benefit to the average seeker after insurance; to expect him to pay for it is unfair. Health appeals and business propaganda are likely to be of negligible assistance to the type of individual who will take the initiative in the purchase of insurance, who realizes that he should plan for the future, that he should be prepared for survival in an era of political and governmental ineptitude.

The Massachusetts experiment has proved that a considerable demand exists for insurance at a fair price, as indicated by a gain in savings-banks policies in that state amounting to 60 per cent during the first seven months of 1931, at a cost to the policy holder that is much less than what is usually considered a normal rate. Faith in political abracadabra has reached so low an ebb that the latest alibi for inaction—condemnation of the dole—has not served to discredit insurance entirely. This publication is still of the opinion that the major worry among the bulk of wage earners is in regard to provision for survival and old age, not against death. Opportunity exists for industry to help the employee by urging and securing the passage of legislation that would permit the enactment of the Massachusetts law elsewhere. As was maintained when less evidence of practicability was available, such a plan should be particularly welcome in mining towns. It would bring business to the local banks, it would stabilize employment, reduce necessity for the charity that is apparently the last resort of political defeatism. Above all, it would enhance confidence in local business and encourage adequate provision for old age. Mining companies might well take direct interest in such a move.

Adjusting International Supply and Demand

A SURVEY of recent history provides convincing proof that the inevitable ill effects of inflation and overproduction were ignored during the boom period, despite the patent fact that an adjustment of supply to demand is one of the most elementary precautions to be taken in the prevention of depression, poverty, and unemployment. Industries and individuals apparently functioned according to the dictates of immediate self-interest, rather than with respect to ultimate benefit to society.

Errors in judgment and practice in the agricultural and manufacturing industries may be retrieved and corrected, and the ill effects mitigated, by remedial action. In the production of metals and non-metallic minerals, however, uneconomic exploitation and marketing methods deplete forever the limited resources available. The rank and file in the mining industries should therefore be gratified to realize that progressive action in the difficult task of coordinating international supply to demand has been taken by industrial leaders concerned with the production of several of these commoditites. Definite progress has been made. A plea by Mr. Cornelius F. Kelley, at the recent meeting in New York of the leaders of the copper industry, in regard to the imperative need for cooperative action, as opposed to unrestricted production and competition, provides an objective that should inspire action on the part of the producers of many basic commodities derived from exhaustible natural resources.

The world is entering an era destined to be involved in important economic, social, and political mutations. Swift and significant changes are to be observed in concept and purpose. What was formerly considered radical has become commonplace and respectable. Reversals of policy and practice, revolutionary in effect on traditional business and trade methods, point the way to a higher plane of industrial equity and justice.

A millennium of international cooperation is not around the corner; but a logical direction of approach has been mapped. The metal and non-metallic mineral industries are indispensable and permanent. Courage and foresight by the leaders of those industries, in the adjustment of supply to demand, will provide a welcome and needed example for the economists, business men, and statesmen of every civilized nation, as well as for the industries and governments especially concerned.

Prospecting and Exploration in Bolivia

James B. Chamberlain

THE mines of the Empress de Estano de Araca lie at the northern end of the Tres Cruces, or Quimza Cruz, mining district in Bolivia. Besides Araca, the district includes the old Concordia, Mallachuma, Monte Blanco, and Chojnacota mines, and the first ground worked by the Caracoles Mining Company of Bolivia, an American company. Tres Cruces district almost coincides in extent with that range of the Eastern Cordillera of the Andes known by the same name. The region is of high altitude, heavy precipitation, and rugged relief. Some of the Araca mines are at elevations of 17,000 ft., and their average elevation is about 15,000 ft. The topographical, climatic, and geological environment at all the Tres Cruces mines is quite distinct from that of the famous Bolivian tin-silver districts at Potosi, Oruro, and Chocaya, and from that of the great tin district which centers about Llallagua.

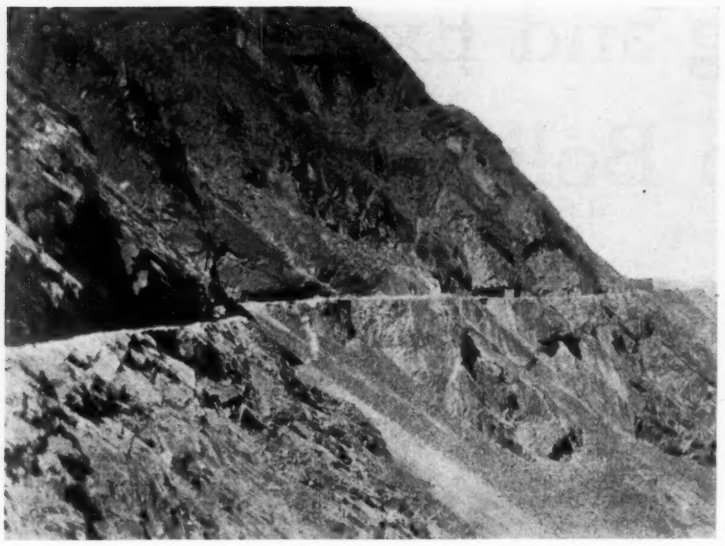
Tres Cruces range trends almost exactly N. 45 deg. W. Its core is composed of an intrusive igneous rock, chiefly monzonitic in composition, that outcrops over an area about 25 miles long by 2 or 3 miles wide. The form of the intrusion is in doubt. Texture of the rock is coarse- to medium-grained granitic, for the most part, though locally porphyritic facies that carry feldspars 3 in. long have been observed. The intruded rock consisted originally of alternating beds of clay, quartz sand, the arkosic sand. Near the Araca mines the grain size of the sediments is very fine, diameters being measured in hundredths of a millimeter. Transition from one bed to another is to a degree gradational. The age of the sediments is Paleozoic, for an abundance of trilobites appears wherever fossils have been preserved. The trilobites suggest an Ordovician or Silurian age for the beds in which they occur. Confident assignment of the economically important beds to a specific geological time period cannot be made, however, for these are close to the intrusive. Strong metamorphic forces have destroyed all of their fossils or disfigured them beyond recognition. The beds near the mines dip away from the intrusive. They exhibit various features caused by metamorphism, jointing and schistose structure being prominent. Rock types into which the sediments have been transformed include slate, quartzite, and quartz-mica schist.

The various mining properties of the district lie scattered along the range, all except Caracoles being principally on its southwestern flank and in the metamorphic rocks. Araca, as already stated, is close to the northern end of the range. The company's mining property covers about 7 square miles, and within it have been recognized some fifty distinct veins, with many additional offshoots and branches. The veins are exploited for their cassiterite content, no other tin minerals being present. A 58 per cent tin concentrate of this mineral is made at the company's mill and shipped to smelters in Europe. As the Araca mines have been active since the late 'nineties and still yield an output that places the company third or fourth among the country's tin producers, the accompanying notes on geological conditions controlling prospecting and exploration should be of interest.

A roughly zonal distribution of vein minerals about the intrusion from which mineralizing solutions were derived establishes the first criterion for deciding the possibilities of a given vein. The contact aureole, about a mile and a half wide, borders the monzonite, into which most of the intrusive magma crystallized, and within this aureole the majority of the tin-bearing veins occur. A few good veins were found in the igneous rock, but, for the most part, those so situated have proved disappointing. Determination of the source of the mineralizing solutions at the time they were circulating in the fractures which are now veins is not possible, but an approximation of distances from this source is secured by measuring distances from the exposed contact. A zone about three-quarters of a mile wide, whose center lies horizontally a little less than a mile from the contact, has been the most favorable one at Araca for the deposition of cassiterite. Pyrrhotite and arsenopyrite are also more abundant in this zone than elsewhere.

At a greater distance than this from the contact, pyrite, chalcopyrite, and sphalerite assume prominence, whereas cassiterite and its accompanying sulphides decrease in relative abundance. Closer to the contact, the proportion of tourmaline increases greatly, and wolframite, scheelite, molybdenite, and a little apatite appear. In veins within, or close to, the intrusive, the tungsten minerals are sufficiently abundant to have made profitable ore during the War. Quartz is ubiquitous, and is the most abundant of all the vein minerals. Tourmaline, too, is omnipresent, for it has never been absent in any vein specimen from the Araca property. Tourmaline crystals, however, diminish both in size and abundance with distance from the intrusive. Near the contact many veins of practically pure tourmaline occur, much of it as needles an inch long. In the zone of cassiterite deposition, however, tourmaline falls to about 10 per cent of the vein filling and occurs in crystals so fine that they are usually not apparent to the naked eye. Beyond the tin-ore zone, tourmaline content of the veins diminishes, though, as already stated, the mineral is always present.

The extraordinarily wide distribution of tourmaline constitutes one of the most difficult aspects of the exploration problem at Araca. Small stringers filled with tourmaline have caused more fruitless driving to be done than any other inspiration of false hopes. The metamorphic rocks are much sheeted and jointed, and such openings are frequently filled with vein minerals that contain some tin. When locally attractive-looking leads are followed a short distance, however, they are prone either to split up into a maze of stringers in which tourmaline and quartz persist, beckoning the optimist on, or they die out altogether. Specimens of country rock in the tin zone, taken several hundred feet from any recognizable vein, show microscopic cracks filled with tourmaline, and the mineral even appears as minute anhedrons, replacing other minerals of the rock or filling any available intergranular spaces between them. The mobility and penetrating power of the solutions that deposited the tourmaline must have been great.



Metamorphic rock near the Main vein. The trail leads to the principal adit of the mine

Other things being equal, zoning might reasonably be expected to produce a series of belts, each carrying characteristic minerals and distributed symmetrically about the mineralizing source. The absence of a stanniferous zone within the intrusive, comparable in importance with that in the intruded rocks, is readily accounted for, however, by the fact that the top of the intrusion has been eroded away. Most of the zone lying at a distance above the mineralizing source equal to that at which the mines now lie horizontally from it has been removed, leaving only the stumps of veins formed in the intrusive. The position of the veins in the intrusive supports this interpretation, for those existent are close to the contact. Farther in the body of the intrusive, where erosion has reached a deeper horizon, even the roots of any veins that may have been formed seem to have been dug out. Prospecting there is evidently an undertaking of small advisability. Bateman and Ferguson[1] pointed out this situation as a common one in connection with tin deposits in an excellent paper published long ago.

All veins on the Araca property dip nearly vertically. On the basis of strike, 90 per cent of them fall naturally into one of two groups: (1) those striking N. 45 deg. E., or within 10 deg. of this direction; and (2) those striking within 10 deg. of N. 80 deg. E. The remaining 10 per cent of the veins fall neither into these groups nor show any consistency of strike among themselves. These veins, however, have yielded only a small amount of ore. Eighty per cent of the oriented 90 per cent, or 72 per cent of all the known veins, fall into the second group, and, with but two exceptions, have been poor producers of tin ore. Their filling is considerably higher in sulphide content and lower in cassiterite than that of the veins of the first group. The remaining 20 per cent of the oriented 90 per cent, or 18 per cent of all the known veins, belong in the first group and, without exception, contain at least one minable oreshoot. The most productive vein on the property, known as the "Main" vein, strikes almost exactly N. 45 deg. E., as does the Inez vein, which is second in output. Four other veins that are, or have been, good ore producers have this same average strike over their exposed lengths. One good vein, the San Antonio, strikes about N. 35 deg. E., and a number of consistent producers show smaller variations than this from the most favorable strike. Pronounced local departures prevail, of course, on each vein from the average strike given, but the remarkably close adherence of the richest veins, as units, to a single attitude is a datum of first importance in the control of exploration workings.

Where the north-east and the east-west veins intersect with displacement, the latter usually appear to be the younger. Some important exceptions to this rule are noted, however among the large number of east-west veins, but the exceptions are not important as veins in the strict sense of that term. They are, rather, fractures, full of fine gouge, but containing little filling of vein minerals.

As to the causes for this relation between the two fracture systems, the microscope gives a suggestion. Polished surfaces of ore specimens show the sulphide minerals to be later than cassiterite; pyrite, chalcopyrite, and sphalerite a good deal later. As the sulphide-rich east-west veins are later than the cassiterite-rich north-east veins, the inference is that north-east fractures were open enough to permit circulation of the mineralizing solutions and deposition of cassiterite when the solutions were most heavily charged with tin, whereas the east-west fractures were open principally at a later period when sulphides were being deposited. But, if this be true, the north-east fractures must have been open also during this latter period, to permit the ingress of the sulphides which they, too, contain.

The best two veins on the property are north-east veins that show evidence of movement by which precisely such later reopenings would have been produced. Indeed, slickensiding of vein walls and filling is the third most consistent feature distinguishing productive veins. The Main vein, for example, has been developed over a length of about 1,500 ft. and a vertical range of 1,800 ft. Throughout this exposure the vein walls and filling show slickensiding so abundantly that no doubt can be entertained that a great deal of movement took place along this plane during and following mineralization. The striæ are short and, at different loci in the vein, assume different directions. The suggestion is of frequent slight movement in relief of accumulated stresses; a type that Hulin[2] has clearly discussed in a recent paper. Study of ore specimens under the microscope confirms this belief, reached in the field, that intermineral movement on the vein played an important part in its formation. To the naked eye, ore of average composition from the Main vein presents a dark gray or brown color and an appearance of fine, even-grained structure. Microscopically, however, as much as 25 per cent of such specimens may be found to consist of fragments of wall rock, evidently dislodged before and during mineralization. They have been so thoroughly altered as to leave but faint traces of their original character. Tourmalinization has been the most prominent type of alteration, though a little silicification has also taken place.

Brecciation, so hard to see on the Main vein, is readily apparent in certain of the other veins. Brecciation, however, is not so reliable a criterion as slickensiding in selecting likely veins for systematic exploration. A common feature of poor veins, as well as of rich ones, where vein mineralization has been strong, brecciation, though present, is likely to be obscured, as in the instance cited.

The best oreshoots in the productive veins have been found at vein intersections or at the intersections of veins and cross faults. The Main vein provides several examples of such shoots, and the Inez and San Antonio veins show others. In fact, that the known and possible intersections of this kind merited favorable consideration soon became apparent in the systematic development of the property. Several gouge-filled east-west fissures, older than the tin-bearing northeast

[1] *Economic Geology*, Vol. 7 (1912), pp. 263-279.

[2] *Economic Geology*, Vol. 24, pp. 15-49.

veins, are also premineral and seem to have been particularly powerful agents in controlling the formation of oreshoots. The Main vein is crossed by one of them, called the Tras Pereo fault, south of which the vein contained ore almost continuously to its southern limit, but north of which ore has never been discovered. The entire character of the vein changes near the intersection of this cross course.

About 30 ft. south of this intersection occurred a roughly lens-shaped oreshoot, about 150 ft. in diameter and, at places, 35 ft. thick. From this shoot, chiefly, came the striking specimens of crystalline cassiterite for which the Araca mines are famous. I have one crystal whose diameter is nearly 2 in., and larger ones were collected by officials of previous administrations. The vein filling in this shoot was practically pure cassiterite, and constituted a real bonanza. A rough sorting by hand of the ore sufficed to yield a product of shipping grade. Three parallel northeast veins intersect the Tras Pereo fault at horizontal distances of 10, 20, and 30 ft. from the Main vein, and on the same levels as the great oreshoot on the Main vein, and in the same position relative to the fault, they too developed shoots of equal richness, though of smaller size. These shoots were likewise on the south side of the fault. North of the fault, the Main vein soon becomes a narrow, miserable-looking crack, filled chiefly with tourmaline and sulphides, though here and there small bunches of cassiterite appear. Farther north, the vein breaks up completely and becomes a net of anastamosing stringers, each stringer being about an inch wide. The three paralleling veins show no signs whatever of continuance beyond the fracture. Numerous less striking examples than this of ore localization at cross-veins and faults might be cited.

The better veins at Araca unquestionably occur in wall rock whose composition is highly siliceous. Whether this composition be due to the original component minerals of the rock, or to silicification accompanying mineralization, is a question which for the present must remain unanswered. The suite of thin sections studied might be interpreted either way; and, unfortunately, they did not include material from points where establishment of the character of the rock might have cleared up the difficulty. Field work was done in Bolivia, and microscopic work in the United States. A number of impasses resulted from this arrangement, of which the aforementioned is the most irritating. My opinion is that the siliceous layers in the metamorphosed sedimentary series tended to fracture more easily than shaly ones, and so provided conduits for the entrance of mineralizing solutions not available elsewhere. This opinion is based partly on the fact that at the Monte Blanco mine, not far from Araca, such is pretty clearly the situation. At Monte Blanco the veins lie between walls of a quartzite that shows under the microscope residual quartz grains surrounded by recrystallized silica after the fashion of typical quartzites. Passage of veins from this quartzite into slate or schist at Monte Blanco usually indicates their end as sources of ore. At Araca the fine grain of all the metamorphic rocks prevents accurate field differentiation of the quartzite from the other types. Underground, its presence is usually inferred where the ground becomes hard. Drilling in the slate and schist is comparatively easy, but in quartzite it becomes laborious. A less satisfactory criterion for judging wall composition is provided topographically. The best veins pass through small ridges and peaks, whose resistance to erosion has probably been occasioned by their hard, quartzose character.

On the Main vein the southern limit of workable ore is reached where ramification similar to that at the northern limit begins, although to the south this seems to have been occasioned by passage of the vein from quartzite into slate and schist, rather than by the influence of a premineral fault. The ramification to the south is more gradual than on the north, and, in the various branches into which the vein divides, good-sized oreshoots of economic grade are sometimes found. The best of these occurs where a branch vein suddenly assumes a dip of 45 deg., instead of the usual vertical attitude. Ore a meter wide, averaging 5 per cent tin, persists throughout the flatter-dipping portion, and narrows to a few inches above and below the point where the vein again assumes its steep inclination.

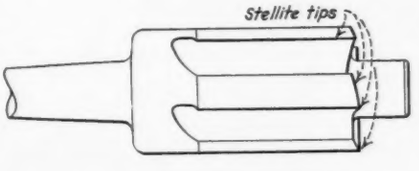
Occurrence of oreshoots at places of changing vein strike are not important. Two minor instances are known where this is probably a factor, but intersecting veins probably had more to do with the localization of the shoots than changing strike.

So far, only the formation of primary oreshoots has been considered. The attack of supergene agents on veins and country rock alike is vigorous in the Tres Cruces region, for much rain and snow prevail. Glaciation is a not inconsiderable force. Near the mines snow fields and glaciers are numerous today, and many cirques, tarns, and moraines indicate glacial conditions of even greater severity in recent geological time. Under such circumstances, oxidation and even solution of minerals easily attacked is never far in advance of erosion. The zone of oxidation is not deep, and chemical activity within it is slow, as a result of low temperature at the surface. Old stopes near the surface often fill up solidly with ice, which is removed with difficulty when work in them is renewed. However, the iron sulphides, pyrrhotite particularly, tend to decompose more readily than one would suppose under these conditions, and, as a result of their removal, the proportion of the insoluble residual minerals, per unit of weight, is increased. The cassiterite content of a few veins (east-west, with high sulphide content) seems to have been increased a little in this fashion, down to the slight depth reached by oxidation. As not more than 20 per cent of the filling of veins with highest sulphide content consists of soluble minerals, however, and as cassiterite constitutes only a small proportion of the insoluble remainder, possibilities for surficial enrichment of any importance by leaching of sulphides are not bright, as a simple calculation shows, and as observation in the field even more convincingly indicates. Ore occurrences at Araca are believed to have been controlled in an overwhelming majority of instances by conditions attending primary deposition, secondary enrichment effects of any kind being negligible.

■ ■

Stellite-Tipped Tools

LACK of suitable tools causes frequent difficulties in machining or repairing machine parts of extra hard material, such as used in mills and crusher. Standard tools, not designed for work of this type, do not stand up, and loss of time and money results. To overcome this difficulty special tools must be obtained either direct from the factory, which is not always practicable because of the time required, or suitable tools must be made locally at a reasonable cost. An innovation in tool manufacture has recently been introduced by F. J. Martin, master mechanic, Miami Copper, Miami, Ariz. Tools made of common tool steel are equipped with carefully dressed and ground cutting edges of stellite. Cost of stellite for tipping the cutting surfaces is nominal; a 2½-in. special drill, shown in the accompanying illustration, was prepared for less than $4.



SMELTING COPPER ORE

In Baja California

Prepared by the technical staff of Compagnie Du Boleo under the direction of

M. Bellanger

Director General, Compagnie Du Boleo, Paris, France

TO UNDERSTAND the metallurgical practice at Santa Rosalia, where the ores from the Rancheria, Santa Marta, Purgatorio and Providencia mines of the Compagnie Du Boleo are smelted, one must study the composition and nature of the ores. Unlike the copper ores mined in the United States and elsewhere, which contain an excess of sulphur and must be roasted to insure successful treatment in reverberatory furnaces, the Boleo ores contain insufficient sulphur for the formation of a convertible matte. They are of clayey nature and have a free moisture content of from 26 to 30 per cent. For metallurgical purposes they have been divided into three distinct groups: (1) sulphurous ores, low in sulphur and iron; (2) oxidized ores, high in silica; and (3) oxidized ores combined with superoxides of manganese. An average analysis of each group is presented in the accompanying table.

Analyses of Boleo Ores

(In per cent)

	Sulphurous Ores	Oxidized Ores	Combined Oxide Ore
SiO_2	42.36	51.06	28.89
Al_2O_3	12.57	3.24	1.26
FeO	11.82	17.40	4.72
MnO_2	4.33	0.83	35.80
CaO	5.57	6.83	3.32
MgO	4.76	3.00	1.69
Cu or CuO	6.33	9.58	10.87
SO_3	0.80	....	.....
S	1.53	0.19	0.07
(Ni+Co+Zn)O	0.46	0.33	0.40
Fire loss	9.58	8.76	13.48

The characteristic features of Boleo metallurgy are: (1) a rich silica slag, containing 51 per cent silica; (2) a high-grade copper matte, with a copper content of 62 per cent; and (3) the addition of a sulphurizing or reducing agent to the charge, to build up the matte. This last feature has presented many problems. Prior to 1922, a matte containing 56 per cent copper was obtained by adding imported pyrites to the charge. A change in economic conditions, difficulties in smelting the charge, and slags containing 0.70 per cent copper that affected smelting costs adversely compelled the discontinuance of this method. Elaborate research and experimental work was started in 1922 to determine a more satisfactory process. Experiments conducted with a mixture of gypsum and coal, bound with fuel oil, on sulphurous ores were so encouraging that tests were extended to oxidized ores. Calcium sulphate, which is reduced at 800 deg. C. to sulphide of calcium, was employed for the sulphuration of the iron of sulphurous or oxidized ores, transformation of copper oxides into sulphides, and reduction of superoxides of manganese. Sulphurous ores at Boleo contain sufficient calcium, barium, manganese, and magnesium sulphates, and require no addition of gypsum. The sulphates are reduced to sulphides by the addition of 2 per cent coal. Matte obtained from such a charge contains from 63 to 65 per cent copper, with slags assaying 0.45 to 0.50 per cent copper.

Tapping reverberatory slag

Oxidized ores contain little sulphur, and need the addition of sulphur and iron to build up a convertible matte. Tests revealed that, to obtain normal slags and a matte assaying from 56 to 58 per cent copper, the percentage of reducing agent added to the charge must be above the calculated amount, and should come in immediate contact with the copper. The mixture generally used consists of: gypsum, 75 per cent; coal, 24 per cent; fuel oil, 1 per cent. The amount of the mixture necessary to obtain a 56 per cent copper matte is 5.2 *n*, where *n* is the quantity of copper in the ore. Oxidized ores combined with superoxides of manganese could be reduced directly with the addition of coal. Experiments, however, showed that this was impracticable, owing to the reduction of copper oxides with formation of metallic copper. To avoid this, the aforementioned reducing mixture was used. Ores that produce a slag with an abnormal silica content are, therefore, treated economically in reverberatory furnaces; and oxidized ores are reduced as successfully in reverberatory furnaces as sulphurous ores, by the addition of a suitable sulphurizing agent.

The Boleo smelter is at Santa Rosalia, along the seacoast. Ore from the mines is delivered in 6-ton railroad-type bottom-dump cars to the bins of a 2,000-ton storage plant. The bins are wood-frame structures, linked together by a belt-conveyor system. Coarse ore from the bins is evenly fed onto a metallic conveyor by automatic feeders, and conveyed to two hammer crushers, driven by 80-hp. motors equipped with magnetic clutches. The minus ½-in. product of the crushers falls into a concrete sump, whence it is raised by three bucket elevators and conveyed to one of four crushed-ore bins. Samples are taken periodically by an automatic sampler installed near the elevator discharge. Fine ore is delivered direct to the crushed-ore bins. Automatic feeders and short belt conveyors introduce the ore into four 7x70-ft. Allis-Chalmers rotary dryers, each of which has a capacity of 300 tons a day. Two of the dryers are oil fired, and two utilize waste heat from the reverberatory furnaces. Moisture in the ore is reduced from 28 to 4 per cent. Ore, discharged at a temperature of 200 deg. C., is elevated and passed through a second sampler, and discharged into a second series of bins, known as the crushed-dried-ore bins. From these it is delivered over a conveyor system, equipped with automatic mixers, to the reverberatory department.

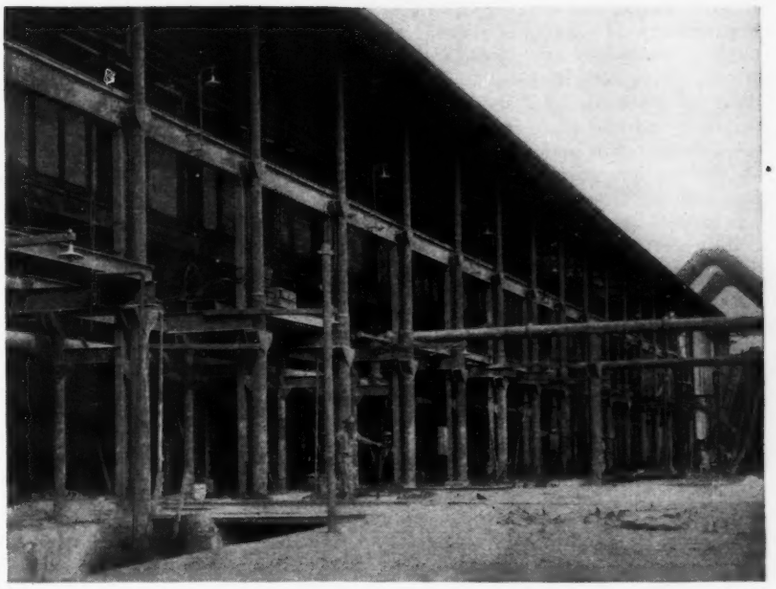
Gypsum, mined from large deposits near the smelter, and coal are delivered to separate bins at the smelter storage plant in the same manner as the ore. Each is first crushed to minus ⅛ in., and then stored in wooden bins. Coal and gypsum drawn from the bins are mixed automatically with a proportioning apparatus, and fed to an Allis-Chalmers

This is the second of two articles by the technical staff of Compagnie Du Boleo on the operations of the company at Santa Rosalia, Baja California, Mexico. The first article, which appeared in a recent issue, described the mining of Boleo ores.

rod mill, where they are reduced to 150 mesh. Fuel oil is introduced in small quantities at the feed end of the mill, by a simple pipe arrangement, to cut dust losses to a minimum. The discharge of the rod mill is delivered by a belt conveyor to the main flux storage bin.

In the reverberatory department, six units of 250 tons' capacity each, measuring 22x72 ft., are available. The furnaces are of the usual silica-brick construction and use oil as fuel. Normally, four furnaces are in operation. The furnace arch is made in one 24-ft. section and three 12-ft. sections. A space of 1½ in. is provided between each section, to allow for expansion. Twelve-inch silica bricks are used for the first 6 ft. of the arch, 21-in. bricks for the next 12 ft., 18-in. bricks for the following 6 ft., and 15-in. bricks for the remainder of the roof. Aluminous silica bricks are used for the uptakes. The life of the first arch section averages thirteen months. This period can be increased considerably by applying a cooling system, consisting of a portable fan and a series of perforated pipes, and by changing the contact points of the five burner flames.

Primary air on the three inner burners is 50 oz., and on the two outer burners 40 oz., with an oil pressure of 35 lb. Secondary air is introduced around the burners by induced draft. Oil consumption per ton of solid charge is 1.1 bbl. with fuel oil, and 0.92 bbl. when using Dubbs oil. The feed mechanism of each furnace consists of a short belt conveyor and a movable tripper, which dumps the charge into the two 42-ft. sheet-iron troughs attached to the furnace walls by fourteen tubes. Continuous feeding is practiced on all furnaces. The charge is distributed for a distance of 24 ft. along the side walls. Slag is tapped at the uptake end, and matte at the side of the furnace. The charge averages 4.5 per cent copper.



The reverberatory building

The converter equipment consists of two 12x15-ft. basic-lined converters. An air-cooled hood covers the mouth of each converter, and conveys the escaping gases to the wedge-shaped flue, connected to a steel stack. The blast pressure is 14 lb., the air being delivered through seventeen 1½-in. tuyères. Flux consists of 15 per cent silica bricks and 85 per cent reverberatory slag. About seven tons of flux is used to blow 40 tons of blister copper, assaying 99.50 per cent copper. The matte from the reverberatory furnaces is discharged into cast-iron ladles and conveyed to the converters by an overhead crane. Converter slag is returned to the reverberatory furnaces in the same manner. Blister copper from the converters is poured into the molds of a locally made casting machine. From the casting floor a steel conveyor elevates and transports the blister cakes to yards for temporary storage preliminary to shipment to Tacoma or to Europe.

Reverberatory slag is granulated by sea water and carried on a pan conveyor and through a series of concrete flumes to specially designed slag barges, whence it is discharged at sea. Sea water for granulating operations and for condenser cooling at the power house is obtained from three elevated tanks. These receive the water from a central pumping plant, equipped with seven automatically controlled Sulzer pumps, driven by 40-hp. motors, with a total capacity of 200 cu.m. an hour.

The power house, adjoining the reverberatory building, contains: one Sulzer steam engine, coupled to a 200-kw. Oerlikon generator; three Sulzer steam engines, coupled to a 400-kw. Oerlikon generator; two Brown-Boveri 1,600-kw. steam turbines; one Allis-Chalmers 500-hp. steam-driven blowing engine, supplying converter air; two Sulzer steam engines, 100-hp., coupled to the condenser pumps; one centrifugal Rateau blower, driven by a 360-hp. steam turbine; two Corliss steam engines, 150 hp., coupled to Root blowers, supplying reverberatory air.

Steam is generated in six Stirling waste-heat boilers connected to the uptake end of each reverberatory furnace. Each boiler contains a heating surface of 34 sq.ft. and produces about 83.33 tons of steam a day, representing a fuel ratio of 6 lb. of steam per pound of oil at the furnace. Waste-heat gases from the boilers discharge into a masonry flue one-half mile long, with a cross-section of 17 sq.ft., built on the declivity of a hill 300 ft. high, near the smelter.

The mechanical and electrical departments of the smelter consist of a large foundry, capable of producing ten tons of castings a month; machine, electrical, boiler, blacksmith, pipe, and pattern-

Part of the yards at the smelter

making shops; and a tool room. Every department is well equipped with modern machinery and tools, and electrically driven cranes facilitate the handling of material. All shops are connected by narrow-gage tracks. Besides the general repair and construction work at the smelter and harbor, the shops also execute orders for the mines. The mechanical department employs about 210 men.

Locomotives, cars, and trucks are repaired in an annex, south of the general repair shop. A sawmill, near the harbor, is operated about ten days a month, and provides sawed and framed timber for the mines. Timber for construction and building purposes is prepared in the adjoining carpenter shop. The transportation department employs 100 men, who unload materials and supplies, load blister copper, and distribute goods from the warehouses to the mines and smelter. Four motor trucks of 2½- and 1½-ton capacities facilitate the transportation of men and materials to points removed from the railroad lines. A modern ice plant furnishes 15 tons of ice per day to the camp and hospitals.

The company maintains a large hospital at Santa Rosalia, equipped with an X-ray apparatus, and an emergency hospital at each mining settlement. The medical staff consists of six doctors, nurses, and attendants. Medical care and hospitalization are free to all Boleo employees. Compensation to the extent of 55 per cent of daily earnings is paid, in the event of an accident, to men with three or fewer dependents, and 85 per to men with more than three dependents.

To protect the population against typhoid fever, the company has installed in Santa Rosalia, and in every settlement, water-purifying plants, of the "javelisation" or "verdunisation" type, used in France during the World War. The company also maintains its own school system, employing thirty teachers. Besides the school house at Santa Rosalia, which accommodates 600 children, additional attractive school houses have been erected in each mining center. The number of pupils enrolled totals 1,300.

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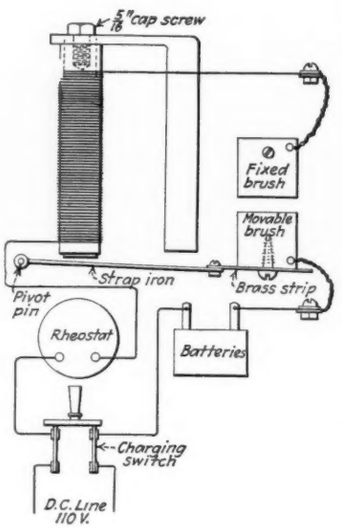
Automatic Reverse Current Cutout

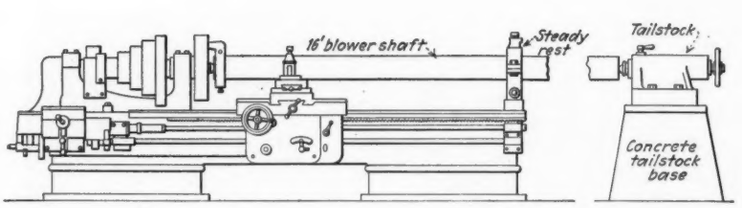
THE charging set for safety-lamp batteries was frequently left in closed circuit during the regular shutdown at noon, with the result that the batteries would discharge through the exciter circuit, writes Thomas C. Hulton, master mechanic, Cia. Minera Chambas, Abras Grandes, Cuba. This difficulty was overcome by the aid of an inexpensive, locally made cutout, shown in the accompanying sketch. A magnet was made from a piece of ½-in. pipe with a cover of shot paper, wound with 140 to 150 turns of No. 20 magnet wire, and filled with a ⅝-in. rod, drawn filed to fit tight in the pipe. The other leg of the magnet consisted of a flattened piece of ⅝-in. rod, bolted to the end of the pipe. Contact was made by a pair of old generator brushes with pigtails, ⅝x1¼ in., the movable brush being fastened to a light strap secured by a pivot pin.



An interruption in the power immediately causes the movable brush to drop down, thus breaking the circuit. When the power returns, charging is again resumed by moving the brushes together, though in the device described, this has to be accomplished by hand.

Novel Blower Shaft Repair

WORN crusher, pump, or blower shafts must occasionally be rectified in the lathe and provided with a new set of bearings, to eliminate vibration, noise, and loss of efficiency. With proper repair facilities this is comparatively simple, especially when small shafts are handled. Large shafts, however, usually present difficulties and require a careful lathe set-up. M. J. Reardon, Old Dominion, Globe, Ariz., was recently confronted with the problem of turning a large blower shaft, but, unfortunately, no lathe large enough was at hand. The difficulty was solved in the following manner:



To provide the required space for the shaft between the live and dead centers of the lathe, the tailstock was removed and carefully mounted on a concrete base, as shown in the accompanying illustration. Owing to the length and weight of the blower shaft, the steady-rest was placed at the end of the lathe bed, providing extra stability and easing the pressure on the lathe centers.

OPEN-PIT MINING

Equipment and practice at the Wabigon, Mesabi Chief, Susquehanna, and Wakefield properties, in the Lake Superior iron region. The first of a series of three articles.

A. H. Hubbell
Associate Editor

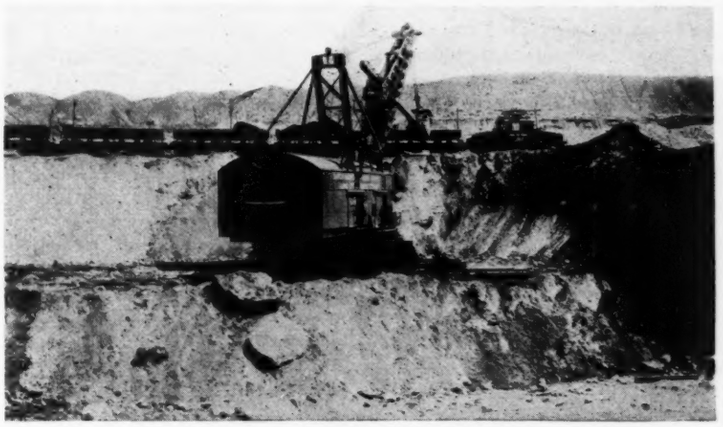
THE open pits of the Mesabi have long served as show places for tourists and as themes for writers in Sunday supplements; and justly so. But inasmuch as the appeal for the person not otherwise interested in mining has been mainly in the heroic size of the excavations and in the gigantic scale of shovel operations, the result has been that the largest of the pits—the Hull-Rust-Mahoning and possibly one or two others also of striking dimensions—have received the most publicity and have served as types or samples on which the average visitor has whetted his curiosity. There are other less well-known open-pit iron mines, on the Mesabi and elsewhere in the Iron Country, that have features of interest aside from mere dimensions. These, after all, are dependent to a large extent on the accidental size of the original deposit and the length of time it has been worked. Of mere size one may say that a mine is at its largest when it is nearest the oblivion of exhaustion.

Among the pits of special interest are the Mesabi Chief and the Wabigon, of the Hanna Ore Mining Company; the Susquehanna, of the Susquehanna Ore Company, operated by the M. A. Hanna Company, mining operators of the National Steel Corporation; the Hill-Annex, of the Inter-State Iron Company, on the same range, at Calumet, Minn., these all on the Mesabi; the Evergreen, of the Evergreen Mining Company, at Ironton, on the Cuyuna Range; and five pits in Michigan—the Wakefield, another Hanna operation which is on the Gogebic Range; the Plymouth and the Volunteer, operated by Pickands Mather & Company; the Tilden pit, of the Cleveland-Cliffs Iron Company; and the Richmond, of the Richmond Iron Company, the three latter being on the Marquette Range. Opportunity to visit these mines was accorded me recently by their operators, through whose courtesy it is possible to present the following notes.[1] Owing to varying circumstance of time and convenience, the descriptions given of some operations are more thorough than could be accorded, practicably, to others.

[1]Circumstances have forced the omission of notes on the Hill Annex, the operators preferring to remain silent regarding their mine until a later date. The writer was unable to visit the Tilden, but this properly will be described in an early issue by Mr. W. R. Meyers, superintendent in charge.

Contributing to the interest of the Mesabi Chief and Wabigon is the fact of their complete electrification. Likewise, at the Susquehanna, haulage has been electrified, though in a very different way. The Hill Annex is the latest of the Mesabi pits to achieve complete electrification, and, tantalizingly, the new equipment has stood idle and ready since Jan. 1, awaiting betterment of economic and industrial conditions. The Evergreen pit was described briefly in a recent issue, and is of interest because of its operation in conjunction with a sintering plant, to supply which, selective mining and grading must be carefully practiced in the pit. The other mines mentioned are worthy of attention in that they, of all the many iron mines on the Michigan ranges, are the only open pits in that part of the Iron Country, and, in addition, four of them have certain features of special interest: The Wakefield has been provided with equipment for electrified haulage by the Differential system, like that in the Susquehanna, though of narrower gage and not yet in commission; the Volunteer is equipped with the Woodford remote-controlled electric-haulage system to facilitate haulage on its steep grades; and the Tilden is a recently opened pit in which a siliceous grade of ore is being mined with the aid of blasting on an extensive scale. The Richmond pit, which is operated by the Hanna company, is a well-equipped siliceous iron-ore property near Palmer, Mich., its equipment including an electric shovel, Differential-type motorized haulage cars of narrow gage, and a model crushing plant.

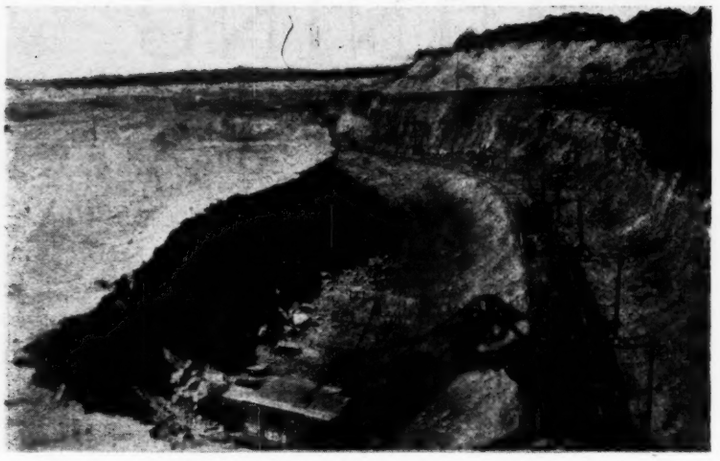
From the foregoing the reader will properly deduce that the Hanna company, of which Mr. E. E. Hunner is general manager and Mr. R. S. Walker consulting engineer, has been the leader in electrification of open-pit haulage in the Iron Country. To their credit they already have two pits completely electrified, a third pit electrified as to ore haulage and shovels (the steam locomotives will be through rock work next year), and a fourth one on the way. Under Mr. Hunner, Mr. Carl Hedman, general superintendent at Hibbing, has charge of the company's Minnesota operations, and Mr. George M. Cannon, assistant general manager, at Iron River, of those in Michigan.



First all-electric open-pit installation in United States, located at Wabigon mine, on the Mesabi.. A 300E Marion full-revolving electric shovel, with 8-yd. dipper, loading stripping. In the background, the stripping train of 20-yd. dump cars hauled by 60-ton electric locomotive. In the distance, beyond the pit rim, is the stripping pile overcast by same shovel working as a dragline in the early days of the operation of this pit.

The Mesabi Chief and Wabigon

Three "forties" in Itasca County, Minn., on the western Mesabi, near the village of Keewatin, comprise the Mesabi Chief ore holdings, this ground being leased by the State to the Great Northern Iron Ore Properties. The property is operated for the latter by the Hanna company. Both direct-ship-



Looking along north edge of Mesabi Chief pit. A 120-B shovel loading the lower wash-ore layer into 30-yd. Differential dump cars.

ping and wash ore are produced. A screening and washing plant with a capacity of 380 tons of crude ore hourly is situated about 1.5 miles from the pit. Although known for years for its reserve of iron ore, the property remained unopened until 1928, when stripping was begun. Concrete work for the plant was started in the fall of that year, steel erection on Jan. 6, 1929, and in June, practically on the appointed day, operation was begun without an untoward incident save for a few leaks in the pipe line, and the first shipments of ore were made. Shops, offices, and other buildings at the mine are of substantial brick construction.

Electrification of the Mesabi Chief was preceded by that of the Wabigon pit, at Buhl, on the eastern Mesabi, by about five years, the former job having been completed in August, 1924. The Wabigon was the first open-pit mine in the United States to use electricity as its sole source of power. At the time of my recent visit, the Wabigon was idle, resumption of operations after the usual winter shutdown having been delayed. References to the operation are based on observations made a few years ago.

Haulage at the Wabigon was electrified in 1924 by installing three 60-ton electric locomotives. In 1919, the shovel work had been electrified to the extent of installing an electric 300-ton full-revolving Marion Model 300E shovel for stripping and loadng ore.[2] With the foregoing, a smaller 60-ton electric Bucyrus 50B shovel, full-revolving and crawler-mounted, was used for the work requiring a smaller unit. Both shovels have d.c. motors operated through motor-generator sets, the larger having full Ward Leonard control and the smaller partial rheostatic control. Power for operation was bought from the Minnesota Power & Light Company at 20,000 volts (3 phase, 60 cycles) and stepped down to 2,200 volts for the shovels and to 445 volts for rotary converters, which furnish d.c. current at 600 volts for haulage. The trolley wire, on main tracks and approaches, was and is carried above the track center, 22 ft. above the rail, and, on entering the pit, on temporary stands so placed as to support it 10 ft. laterally from the track center and 15 ft. above the rail, this so that the wire does not interfere with shovel or crane.

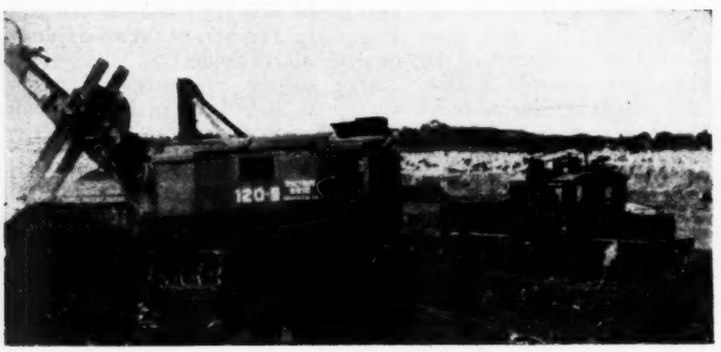
As installed, the Model 300E shovel at the Wabigon had an 80-ft. boom and an 8-yd. dipper, capable of dumping 56 ft. above the rail within a 95-ft. radius. Equipped as dragline, it had a 155-ft. boom. The smaller shovel had a 1½-yd. dipper and a 36-ft. boom, and could dump about 35 ft. above the rail. All electrical equipment of the shovels, as well as of the locomotives and substations, is of General Electric make and was described in detail, including operating costs obtained, in the *General Electric Review*, September, 1924, by Mr. Walker. The locomotives, each 60 tons, are strongly built, equipped with both overhead pantograph collectors and side-arm collectors, and from the outset have given considerably lower operating and maintenance costs than the steam locomotives previously used.

At the Mesabi Chief, loading, haulage, and transport equipment includes three electric shovels, four electric locomotives, and sixteen air-dump cars. Two of the shovels are the Bucyrus Model 120B, mounted on crawlers, each having a 32-ft. boom and a 4-yd. (water level) dipper, and the third shovel being a Model 225B with a 90-ft. boom and an 8-yd. dipper. The last can be converted to a dragline, using a 155-ft. boom and an 8-yd. dipper. All three have d.c. motors and Ward Leonard control, taking 3-phase, 60-cycle current.

Transformer station, Mesabi Chief pit.

In designing the locomotives, advantage was taken of the experience gained with those at the Wabigon. The Mesabi Chief locomotives are eight-wheel 60-ton G.E. units, each of 14 ft. 10 in. wheelbase and having four 150-hp. 600-volt d.c. traction motors and semi-elliptical gears, which develop a tractive effort of 7,400 lb. at 14.5 m.p.h. continuously (27,000 lb. at 8.2 m.p.h.) and a maximum effort of 30,000 lb. on starting and accelerating. Each is equipped with Type M, two-speed control and standard Westinghouse automatic and ordinary air-braking equipment, with the compressor in the cab, along with the control contactors and resistors, all of which are in a separate compartment. Ventilation of the latter is effected by a stack through the roof and by holes along the bottom of the compartment. This departure from the usual arrangement was made so that the space ordi-

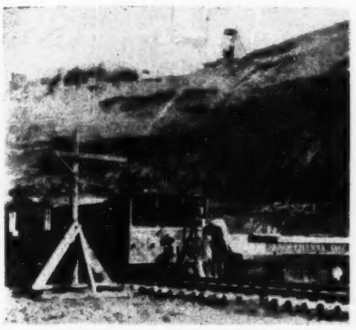
[2]This shovel and a 225B Bucyrus 300-ton full-revolving electric shovel installed the same year by the Hanna company at its La Rue mine, at Nashwauk, Minn., were the first two electric shovels used, according to Mr. Hunner. New details on this and other equipment mentioned were worked out by Mr. R. S. Walker and other Hanna engineers cooperating with manufacturers' engineers.



In the Mesabi Chief pit. A 120-B full-revolving Bucyrus electric shovel, with 4-yd. dipper, loading paint rock. At right, one of the 60-ton standard-gage electric locomotives.

narily occupied by the contactors in dummy cabs might be used for ballast tanks filled with iron punchings and cement, this being cheaper than using steel billets in the locomotive frame. The cab was equipped with single control only, and standard short shank couplers were used.

Overhead collection of current, such as was used on the main approaches and in the ore yards at the Wabigon, as described by Mr. O. O. Ormond (then superintendent of the Wabigon) in *E.&M.J.* July 24, 1926, was abandoned at the Mesabi Chief, in favor of the side-arm collection previously developed at the Wabigon for use in connection with temporary tracks in the pit and on the dumps, this method of collection having proved satisfactory for all purposes and cheaper to install. At the Mesabi Chief, the trolley wire was therefore placed 15 ft. above the rail and 10 ft. laterally from the track center, as for side collection at the Wabigon. Along permanent tracks the wire is carried by brackets on poles, and from portable stands along the temporary tracks.

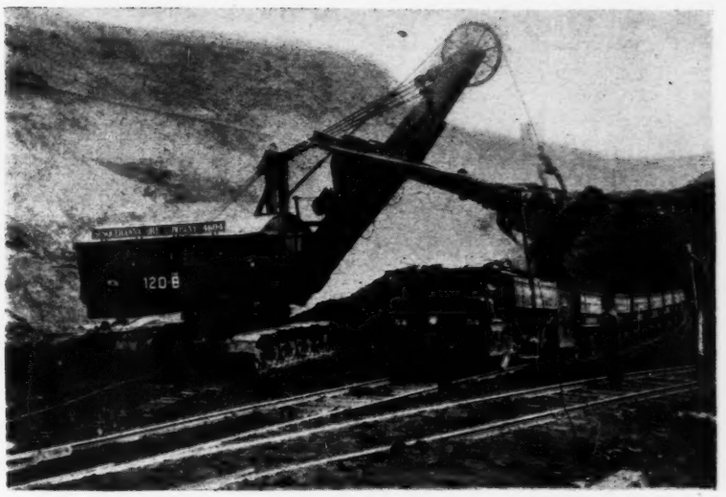


At left, one of the portable stands, colloquially termed "Christmas trees," used to carry trolley wire in Susquehanna pit. Similar stands are used in Wabigon and Mesabi Chief pit.

These stands may be either the wooden frames, colloquially termed "Christmas trees," developed at the Wabigon, or poles set in churn-drill holes. On the locomotives, two collectors, one on each side, are mounted on the cab, from inside which they are operated by compressed air. They are of the pantograph type and designed to keep the shoe horizontal.

Current at 20,000 volts purchased from the Minnesota Power & Light Company is stepped down to 600 volts, for the locomotives, and to 2,200 volts, for the shovels, at a substation (shown in a cut) located at the approximate center of gravity of the electric load. This station is equipped with two types of transformers, one for a 6-phase, 500-kw. 600-v. d.c. synchronous converter and the other for the shovel circuit.

The 30-yd. air-dump cars used at the Mesabi Chief are of the side-pivot drop-door type, of Differential make, and handle stripping and wash ore, the latter between pit and plant. Other equipment is a Bucyrus spreader, used on the dumps, and a Nordberg track shifter.

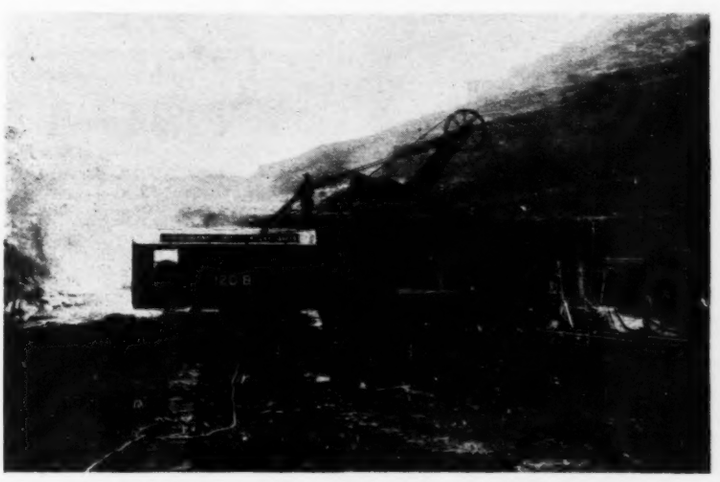


At the Susquehanna mine, on the Mesabi. A 120B Bucyrus full-revolving electric shovel, with 4-yd. dipper, loading a train of 4-yd. Differential cars hauled by a special Differential locomotive car, weighing 22 tons empty and 30 tons loaded.

The Susquehanna Pit

Electrification has proceeded along somewhat different lines at the Susquehanna pit, so far as haulage is concerned. The property, which is at Hibbing, on the Mesabi, is equipped to handle 1,000,000 tons, in a season of seven months. It has long been a producer, with almost 11,000,000 tons to its credit up to the beginning of 1930. For several years prior to this date it had been worked by electric shovels, steam shovels, and railroad cars. As the pit deepened within its restricted area, track grades eventually became too steep and long for economic haulage with standard locomotives. The problem thus presented was met by sinking a 350-ft. five-compartment shaft (two skips, cage, counterweight, and ladders) alongside the pit, driving a haulage tunnel 260 ft. below the shaft collar from the shaft into the pit, and hauling the ore from pit to shaft in cars loaded by the shovels. At the same time, for drainage purposes a second similar haulage tunnel was driven under the pit and 60 ft. deeper, the intention being to use it for haulage when the pit has deepened sufficiently to require it, at which time a third haulage tunnel 60 ft. deeper than the second tunnel will be driven to the pit to exhaust the pit ore, and drainage will be taken care of by deep-well pumps installed in secondary shafts sunk in the bottom of the pit.

The shovels used are three full-revolving Bucyrus Model 120B, mounted on caterpillars and having 4-yd. dippers and 32-ft. booms. They take power at 2,200 volts, a.c., and are equipped with Ward Leonard control and a five-unit motor-generator set. These were the first of this electric-driven type to be used in open-pit mining.



Another view of Susquehanna mine, showing electric shovel and Differential train. Note portal of tunnel (at right) leading to the 350-ft. shaft.

To facilitate pit loading and shaft hoisting, the respective capacities of dipper, car, and skip were made the same—that is, 4 cu.yd. For the dipper this is the so-called water-level capacity. Thus each car will take a dipperful and each skip a carload.

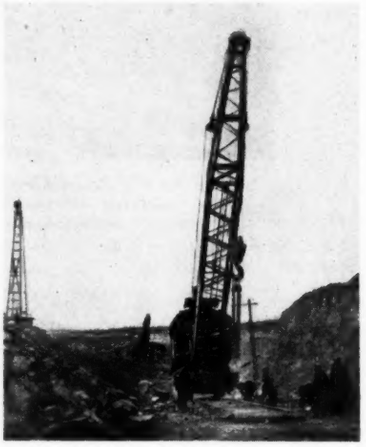
For haulage from pit to shaft the "Differential" train developed by the Differential Steel Car Company, Findlay, Ohio, is used, the track being standard gage (4 ft. 8½ in.) in pit and underground. Adoption of this track gage has permitted steam locomotives, hauling rock encountered in mining ore, to run over the same pit tracks as those used by the ore trains. The broad gage has greatly increased the steadiness of riding of the carloads of ore electrically drawn to the shaft, thus permitting fast transit with minimum spill and greater safety than would obtain if a narrower gage were used under the large, heavily loaded cars.

The principle involved in the design of the train has been explained briefly in an earlier issue.[3] The train consists of six 4-yd. cars, hauled by a locomotive car, which also carries a 4-yd. (8-ton) load and is otherwise much the same as the trailers save that it is motorized. When the seven-car train is loaded, the 4 tons added to the weight of the locomotive car increase the tractive effort sufficiently to enable it to haul the loaded train. When the train is empty, the locomotive weighs 8 tons (4 yd.) less, but is still heavy enough to haul the six empty trailers. The net result is that the seven-car train weighs less loaded (18 per cent less) or empty (10 per cent less) than a standard locomotive with seven trailers correspondingly loaded or empty. A further saving in power is effected by the fact that the rolling friction is less because the Differential train has one car less than a train of seven cars hauled by a standard locomotive.

The cars (locomotive and trailer alone) have bodies that can be dumped to either side by an air-cylinder trunnioned under the center of the carbody. Inspection and repair can be effected easily with the body in the dumping position. The doors are hinged at the bottom and turn out and down. The trailers have four 20-in. wheels, each equipped with Timken bearings in the hub and with air brakes. All cars have auto couplers.

Differing from the trailers, the locomotive car has at one end an engineer's cab housing controller and contactors, valves for operating the air brakes, the side-arm collectors and sanding, and the compressor governor. At the opposite end is a dummy cab housing the compressor and the reservoir. The compressor is a G.E. Type CP 130, 50-cu.ft., 600-volt machine. Two motors are used, both G.E. traction Type HM—840 units, 95 hp. each and 600 volts. The top of the cab is flush (7 ft.) with the top of the car body to clear the tunnel timbers. The locomotive car has 33-in. (steel) wheels and a wheelbase of 11 ft.

Current is collected in the pit or in the tunnel by one of the two side-arm collectors mounted on the sides of the cab. In the pit, the trolley wire is carried 8 ft. 6 in. above the rails and 8 ft. laterally from the track center. In the tunnel it is the same distance above the rails as outside, but only 2 ft. laterally from the center. The arms can be swung 180 deg. by an air-operated rack-and-pinion, and, if desired, stopped manually halfway. The engineer can swing both arms outward simultaneously, but can swing only one arm inward at a time. While it is being swung, the arm is kept depressed by a cam. When taking current it is held against the wire by springs.



Shifting track, in the Mesabi Chief pit

A 300-kw. 6-phase synchronous converter supplies d.c. power at 600 volts for haulage. It is protected with overload, phase-balance, bearing-temperature, and ground-protective relays. The feeder panel has automatic reclosing features.

Underground at the shaft, provision is made for dumping two cars at a time, the track layout permitting rapid handling. The hoisting scheme calls for handling one (8-ton) skip per minute. The skips are hoisted in balance by an Ottumwa hoist, geared to a G.E. 500-hp. 360 r.p.m., 2,200-volt slip-ring induction motor. They were supplied by the Lake Shore Engine Works of Marquette, Mich. Cage and counterweight are handled by a hoist of similar make driven by a 150-hp. slip-ring motor.

At the collar, the bins, headframe, and tracks are laid out to permit handling three grades of ore (bessemer, non-bessemer, and screened), and waste rock derived from screening; also 180 railroad cars a day. The skips dump into a single pocket from which the ore is removed and delivered to the railroad pockets by a clamshell type remote-controlled larry car, described by A. F. Gettelman[4] in an earlier issue. This car is operated by rope haulage and a 7½-hp. motor. Its movements are controlled by pushbuttons operated by the hoisting engineer, who is signaled the grade of ore by the skip tender. The latter indicates the grade by flashing the proper one of four lamps on a panel in the hoist room. This he does by inserting a plug in the corresponding one of four receptacles on a panel in the station. Below each light on the hoist man's panel is a receptacle corresponding to the ore pocket into which is dumped the grade of ore signaled. By plugging the proper receptacle, the hoist man causes the larry car to move to the corresponding bin. Here it is automatically stopped by a limit switch given a 10-sec. delay for dumping, then automatically returned to the shaft, where it is again stopped by a limit switch, a lamp signaling the hoist man of its return. The longest car-cycle is 20 sec. faster than the skip-hoisting cycle.

Serving the four pockets are four parallel railroad tracks and one "run-around" track, all of which run into a common ladder track that extends into a long tail track above the shaft. These four tracks also extend below the shaft, so that there is, on an average, 700 ft. clearance above and below the shaft for storing empty and loaded cars respectively. The tracks above the shaft have 1.75 per cent grade and those below have 1 per cent. Trains passing beneath the four pockets are under air control at all times. The pocket chute gates are air-operated from an air switchboard tended by one man. Mr. W. E. Craig is superintendent of this interesting property.

Power is purchased for the Susquehanna from the Minnesota Power & Light Company at 20,000 volts and is stepped down to 2,200.

The Wakefield Pit

About 20 miles east of Ironwood, Mich., are the only open-pit mines—two in number—of the Gogebic Range. They are the Plymouth mine, of the Pickands Mather company, and the Wakefield pit, operated by the M. A. Hanna Company. At the time of my visit the Plymouth was shut down. It is approximately 3,000 ft. in length, and narrow. For sixteen years prior to 1931 it was a steady shipper, with a production of over 8½ million tons to its credit up to 1930. A non-bessemer grade is produced, known as the Plymouth, the average of all cargo analyses in 1929 having been 48.36 per cent iron, natural; 19.13 moisture, 0.074 phosphorus, 3.11 silica, 1.52 manganese, and

[3] *E.&M.J.*, Feb. 28, 1930, p. 151; also June 23, 1930, p. 623.

[4] *E.&M.J.*, Sept. 25, 1930, p. 279.

1.24 alumina. The pit has about 12,000 ft. of track, with a maximum grade of 3 per cent, and is equipped with one 80-ton locomotive and five 60-ton locomotives, all of the switching type, and 25 20-yd. Western air-dump cars.

Immediately east of the Plymouth along the iron formation (which strikes approximately east and west) is the Wakefield, which at the time of the visit in May was running six days per week. A bench resulting from a difference of elevation of the pit floors marks the boundary between the two pits. The Wakefield mine is operated by the Hanna company, with Mr. R. B. Wortley as superintendent. Next to it, to the east, lies the Sunday Lake mine, an underground property operated by Pickands Mather and with a production record stretching back unbroken to 1885. The Sunday Lake ships two grades, a soft bessemer and a hard non-bessemer, the iron running 56.71, natural, and 54.96, respectively.

Stripping was begun at the Wakefield in the fall of 1913, and the first ore dug the following year. Up to 1930 the mine had produced 9,889,860 tons, having started production in 1914. Two grades (formerly three) are shipped: one a manganiferous (Duane) grade which is now and again accumulated up to 5,000 ton lots. In analysis it runs 47.26 per cent iron, natural; 3.03 manganese, 0.099 phosphorus, 18.16 moisture, and 2.95 silica. The other grade is the Inland, running 50.96 iron, natural; 0.088 phosphorus, 16.59 moisture, 2.59 silica, and 1.20 manganese.

The pit is about 600 ft. wide at the top, about 375 ft. deep, and very narrow at the bottom—in fact, so narrow that a railroad-type shovel mounted on crawlers cannot be turned in it. As a result, railway-mounted shovels are employed. To turn one of these it is necessary to run out to a Y, on the surface beyond the pit, and back again, a 7-mile trip. Adding to the difficulty of operation a westward-dipping dike shows in the bottom, about midway of the length. The south side of the pit is rather steep, following the dip of the footwall slates. These are exposed, and, on them to the east, is some red shale with occasional dark patches of ore. A single shovel-cut along the bottom would probably bring these remnants down. In general, only light blasting can be done, because of the character of the banks. During the past winter, the company stripped some hard rock, making difficult shoveling, on the north or hanging wall side of the pit. Some large fragments of it were still in evidence. Most of the remaining ore is on the north side and is now tied up in track benches. To mine it with the method now in use would disrupt the present ore haulage system.

To recover this ore, therefore, a system involving electrification of haulage, with the use of three "Differential" trains of eight 5-ton cars each (including the car box on the locomotive) is to be adopted. The three motorized cars and the 21 trailers have been purchased and are already on the ground outside the pit, awaiting the necessary development work and installation of power. They will be operated on 250-volt direct current. This equipment is similar to that used at the Susquehanna, already described, save that the gage is narrower, being 3 ft. instead of standard. The locomotive cars will be dumped by independent air-dump equipment installed on the locomotives, and the trailers by a stationery dump installed at the underground loading pocket.

In the Wakefield pit, Wakefield, Mich., on the Gogebic Range. Note the steep sides.

Several hundred feet east and south of the pit is a shaft, sunk in 1917 and 395 ft. deep—a little deeper than the present bottom of the pit. Connecting with it near the bottom is a footwall drift, which parallels the pit and from which are turned off three crosscuts, one at each end of the pit and one in the middle, which run under the pit and drain it through three 6-in. churn-drill holes. These holes are cased, the casing projecting 2 or 3 ft. above the top to keep dirt out. The pump station is located close to the bottom of the shaft.

About 200 ft. below the collar of the shaft a drift was driven from the shaft to connect with the east end of the pit. The ore previously mentioned as being tied up by the present approach tracks and track benches will be removed through this drift. It will be dug by full-revolving electric shovels and loaded into the 5-ton Differential cars and hauled through the drift by 20-ton Differential electric locomotives to the shaft, from which point it will be hoisted and dumped into railroad cars at the collar of the shaft.

No storage pocket is provided at the underground shaft station; but a double slide guides the ore from the cars to the hoisting skips, which are of the same capacity as the cars. The cars are dumped by an air-operated dumping mechanism designed for the type of cars used. The headframe is equipped with a two-compartment pocket, each compartment having a capacity of about 70 tons.

A double-drum clutched ore hoist and a single-drum cage hoist and counterweight, good for about 1,500 ft., constitutes the present hoisting equipment of the shaft.

Aside from the Differential trains, the equipment of the pit, as it is today, includes five 60-ton and two 70-ton Baldwin locomotives. Trackage totals approximately 10 miles. For present operations thirty 20-yd. air-operated side-dump cars are used. These have cast-iron wheels.

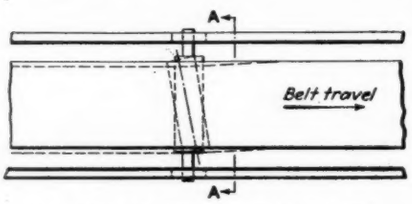
Shovels are four in number and all steam-operated. They include two crawler-mounted full-revolving units, one a 225B of 6-yd. capacity and the other a 1½-yd. Model 35B; also two 3½-yd. railroad-type units (one Model 103C and one Model 85C). In addition, there is one Model 85C caterpillar-mounted shovel, temporarily dismantled. During the season now closing an 80B full-revolving electric shovel was being mounted in the pit.

The Wakefield shop is well equipped for making all locomotive repairs. Its equipment comprises a wheel press, lathes, including those used for turning down locomotive tires; a forge, shapers, and other machine tools, and electric welding apparatus.

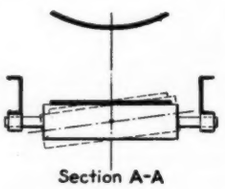
(To be continued)

Aligning Conveyor Belts

MANY ATTEMPTS have been made to find a successful solution of the problem of maintaining positive control of the return idler of a belt conveyor, and of keeping the belt truly on the center line of the conveyor, writes S. D. Robins, engineer on the staff of the Robins Conveying Belt Company. Guide idlers, and rollers acting against the edge of the belt, frequently damage the edges of the belt. Conveyor designers, therefore, adopt an extremely wide clearance



Top view of return strand of belt, showing action of trainer



Section AA, showing vertical action of trainer

between the belt and the conveyor structure as the only sure method of preventing the edges from being torn or cut by contact with the support. In practical operation, however, even a 6-in. clearance on each side has often been found insufficient to afford protection, and some belts are so difficult to train that serious damage from edge wear seems unavoidable.

In my study of this problem I immediately realized the possibility of making the supporting rollers serve as guides for the belt, in addition to their regular function. Principles involved in training the front wheel of a bicycle or an automobile pointed the way toward obtaining this result, which has been accomplished in the so-called Robins "belt-trainer," a training roller which, without the aid of flanges, automatically centers the belt by a rolling contact with the bottom side of the belt only. The device has been found to function regardless of poor adjustment of return idlers or of other disturbing factors such as wind, sticky material on the blet, or bad alignment of the conveyor itself.

The belt-trainer consists of a tubular roller, mounted at its center on a single anti-friction bearing, which is internally pivoted on a fixed swivel pin placed on the center line of the conveyor and inclined forward at an angle of about 30 deg.; thus, the roller is permitted to rotate freely on the bearing, as well as to rock on the pivot. When the weight of the belt is unevenly distributed on the two sides of the pivot, the roller rocks downward on the heavy side. At the same time, the inclination of the swivel pin causes the roller to move forward on the down-side and backward on the up-side, making it skewed in relation to the belt, thus forcing the belt back to the center line of the conveyor. This action is similar to that of moving a heavy object on rollers; by skewing the rollers one way or the other the direction of travel is controlled.

The principle of the device is somewhat similar to that used in bicycle and automobile steering knuckles, where the weight of the vehicle is used to maintain the steering wheels in a central position, or to center them when bumps in the road or other disturbing influences cause a sudden departure from that position. As already stated, this function is performed by the weight of the belt itself, which, if it is off center, causes the roller to rock in such a manner that the belt is again centered. Its powerful action in training a belt may be demonstrated by inclining the pivot in the wrong direction. When the belt is started under this condition the belt trainer instantly flops to an extreme position, causing the belt to run off in a few seconds. Another surprising characteristic is that an uneven accumulation of sticky material on the roller does not impair its qualities. A test of this point was performed by wrapping one-half of the roller with burlap, secured with one wrapping of tire tape, making the diameter about half an inch larger than the diameter of the other half. This made the roller skew at an angle of about five degrees, but the belt remained centered. In this case the skewing of the roller simply compensated for the difference in thickness of the two halves, allowing the weighing or balancing function to remain undisturbed. This is a valuable feature, as uneven adherence of sticky material to the conventional return idler is one of the most frequent obstacles to proper training of a belt.

An automatic reversible type has also been devised for use on belt conveyors designed to run in both directions. The principle of construction is the same, with the added feature that the shaft, instead of being rigidly clamped for a fixed pivot-pin inclination, is mounted in a knife-edge manner at the two ends, so that the reversal of the direction of the belt pull will change the direction of the pivot-pin inclination.

One belt trainer substituted for every eighth return idler has been found to center the belt in all operations thus far observed. As return idlers usually are spaced 10 ft. apart, one trainer will control 80 ft. of belt. Under extra difficult conditions a 50- to 60-ft. spacing may be advisable.

The idea of using a roller mounted on an internal pivot inclined in the direction of belt travel has other applications in addition to the training of conveyor belts. Tightener pulleys for transmission belts, for instance, if of this construction, maintain a proper belt tension and serve to keep the belt in its proper central position.

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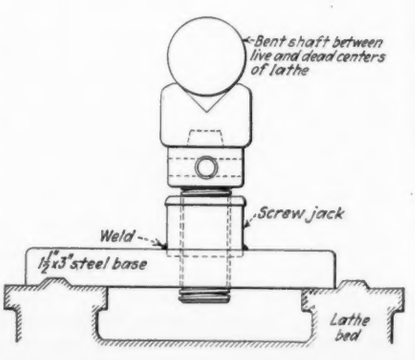
Lathe Screw Jack

STRAIGHTENING of deformed shafts in a lathe if done without proper tools, requires both time and skill, according to F. R. Kennedy, master mechanic, Old Dominion, Globe, Ariz. The usual procedure is to press the bent section of the shaft with the aid of several iron blocks and a steel bar, while it rests between the live and dead centers of the lathe. As much time is consumed in preparation and frequent adjustment of the blocks and bar, and as the danger of hand injuries is great, this precedure was discontinued, and the light screw jack shown in hte accompanying sketch developed. It consists of a threaded nut welded to a 1½x3-in. base, the screw proper being equipped with a revolving head having a machined 90-deg. groove. The groove, machined into the bottom of the steel base, corresponds in shape to the lathe bed ways, to keep the screw jack in perfect alignment with the lathe center. This inexpensie device is a valuable addition to the lathe tool box.



Crushing and drying plant

Bauxite Mining in Arkansas

DEVELOPMENT of the deposits at Bauxite, in Saline County, Ark., by Republic Mining & Manufacturing Company and its predecessors, Pittsburgh Reduction Company, Aluminum Company of America, and American Bauxite Company, covering a span of 30 years, ranks among the important undertakings of the mining industry of the United States, writes T. Shiras, of Mountain Home, Ark. In 1899 the Pittsburgh Reduction Company acquired some of the orebodies now owned by the Republic Mining & Manufacturing Company. During that year the company's production of bauxite amounted to only 1,720 tons. With the growing importance of aluminum the output gradually increased until a peak was reached during the World War, when, in 1918, a maximum of 479,492 tons was attained. After the post-War slump and the depression of 1921 the production again increased, until 1923, when foreign competition made itself seriously felt. In that year a production of 447,898 tons was attained. Average annual production during the following years has been only 279,076 tons, although the plant and mines have an annual capacity of 600,000 tons.

From 1899 to 1923 all mining was done in open pits. After completion of an extensive prospecting campaign with churn drills, which disclosed orebodies at greater depth, underground mining was started in 1922; at present about 150,000 tons, or about half the annual production, is mined at depths ranging from 70 to 180 ft. The ore is hauled to the surface through a main tunnel, 5,200 ft. long, by two 36-in. gage Mancha storage-battery locomotives, of the Hercules AX-type, equipped with Edison batteries composed of 99 cells each; the ore cars are then gathered into trains and hauled to the mill by steam locomotives. About 20 miles of drifts, crosscuts, and stopes has been opened up during the last seven years. All ore cars used, underground as well as in the open pits, are of the Phillips end-dump type, 1½ cu.yd. capacity, built in the local shop. Twelve locomotives and 800 ore cars are required for the entire operation. About 15 miles of narrow-gage track from underground mine faces and open pits to the crushing and drying plant is in use.

The orebody forms a horizontal blanket deposit averaging about 12 ft. in thickness, into which stopes are driven from the main tunnel on 24-ft. centers, leaving 12-ft. pillars between stopes. Expensive timbering is eliminated by leaving about a foot of ore as a supporting roof in the top of each stope. Pillars and roof will be recovered by the retreating caving method, working from the rear of each stope toward the main tunnel, when the limit of the orebody has been reached.

All underground drilling is done with No. 93 Waugh wet rock drills, driven by compressors situated on the surface. For prospecting and deep drilling No. 3½ Joplin Special Keystone Driller is used. Three compressors are in use, an Ingersoll-Rand, type Imperial XRE, 18x11x14 in., duplex, direct connected to a 175-hp. motor, capacity 1,052 cu.ft. per minute; a Sullivan, Type WJ, 24x14½x18 in., belt driven, short center drive, 300-hp. motor, capacity 1,750 cu.ft. per minute; and one Chicago Pneumatic, 15x9x10, belt-driven, 75-hp. motor, capacity 430 cu.ft. per minute.

The property includes numerous open pits, some of which are a quarter of a square mile in area. An overburden of clay, rocks, and boulders, varying from a few inches to 35 ft. thick, must first be removed in open-pit operations. Stripping, mostly by contract, is done by 18B Bucyrus steam shovels, revolving type, caterpillar mounted, with ⅞-cu.yd. dipper. One Bucyrus-Erie, Type 1,030, diesel-powered shovel is also in use. Stripping, as close down to the orebody as possible, is followed by wheel scrapers, cutting the clay down to the ore. Picks and shovels are then used for removing the clay from the pockets. Final cleaning is done by a crew using steel brooms, sweeping the top of the orebody perfectly clean. Should rain wash any foreign matter over the ore after the final sweeping it must again be swept before mining can proceed. Open-pit mining is profitable with an

Open-pit mining with steam shovels

orebody of not less than 10 to 12 ft. average thickness, if the overburden does not exceed 35 ft. With a heavier overburden underground mining is more economical.

Drilling in the open pits is done by compressed air or by churn drills where the cost of running an air line is prohibitive. Holes are drilled to the bottom of the orebody, sprung, and shot with dynamite or black powder. Loading is done by hand or with power shovels, according to the existing conditions.

Three grades of ore are produced—aluminum ore, for production of the metal; abrasive ore, for use in the manufacture of abrasives; and chemical ore, for production of aluminum sulphate. About 60 per cent of the production falls in the first group, 25 per cent in the second, and 15 per cent in the third. Low silica and titanium content are essential requirements of the aluminum ore. Manufacturers of alum and aluminum sulphate prefer ore low in iron and titanium; for abrasive purposes low silica and iron is essential. The different analysis of the three ores produced calls for much care in mining and handling the ore from the different pits and headings. Drill cuttings from all holes to be shot are sacked, numbered, and analyzed daily, that specifications for various orders may be met. Miners and car loaders are kept informed about the grade of the ore they are working, and tags giving the chemical analysis are attached to the cars as they leave the mines for the mill.

Loaded ore cars are hauled to the crushing plant with dinky steam locomotives handling from 30 to 60 cars to a train, and discharged by automatic dumpers into crushers, where the ore is reduced to 3 in. or finer. The crushing plant, which has a daily capacity of about 2,000 tons of crude ore, consists of seven Gibbons crushers, designed by the late General Gibbons, who was the first superintendent of the property, and four McCully gyratory crushers, No. 5 and 8, of standard type. The Gibbons crusher consists of rolls with two ringed cylinders which mesh in such a manner that they perform the functions of a grizzly as well as a crusher.

After screening with revolving screens of Allis-Chalmers make, the crushed ore is taken by belt conveyors to the drying department, where eleven rotary kilns are used, of Bonnot Reeves Brothers and Allis-Chalmers manufacture. Seven of these are used for drying and four for calcining. They are six and seven feet in diameter, eight are 60 ft. long, two 120 ft., and one is 150 ft. Natural gas or crude oil is used for firing. The feed carries from 14 to 18 per cent free moisture. Ore used for abrasive purposes is calcined to remove water of crystallization, amounting to about 30 per cent.

During 1931 operations have been reduced to four days a week, and many economies have been introduced to counteract the present unfavorable business condition and to meet the competition of foreign ores, especially from Europe and South America. No effort has been spared to improve working conditions, and labor turnover is consequently low. Some unskilled Negroes and Mexican laborers are employed. These are segregated in their own well kept settlements in the outlying parts of the town of Bauxite, which has a population of about 3,000, all directly or indirectly dependent on the operations of the company. Saline County, in which Bauxite is situated, receives substantial benefits from the company's activity, as for instance a direct annual tax of $25,000, about a sixth of the taxes paid. In addition, a self-assumed tax of about $40,000 is also paid by the company. Of this amount several thousand dollars is used to make up the deficit in the school budget; the remainder is used to maintain the different departments in the city administration. Town site and buildings are the property of the company. A splendid water system with adequate water for fire protection and an up-to-date sewer system are provided. Cold, clear water supplied for drinking purposes is analyzed weekly to guard against contamination. Almost all of the houses are equipped with electricity and natural gas. Electricity, for domestic purposes as well as for the operation of mine and plant, is furnished from Arkansas Power & Light Company's network. About 500 modern bungalows and cottages comprise the town. Rents are considerably lower than for the same type of buildings in near-by cities and towns.

A modern hospital, three schools, a theater, two churches, and several chapels serve the community in its civic life. The town has no jail and crime is almost totally absent. Twelve councilmen, representing the different wards, and a town manager constitute the governing body. The town manager has charge of all buildings, streets, lights, water, sewerage, mosquito control, and similar activities. Acting in close conjunction with the town manager is the director of personal relations, who employs all labor, makes house and boarding house assignments, looks after the social welfare of the citizens, and performs all duties of a similar nature.

Three general superintendents have been in charge since active mining operations first started. The first was General Gibbons, who served from 1899 until his death in 1919. John T. Fuller served from 1919 to the end of 1924, when he was given another high position with the company. L. R. Branting, the present general superintendent, succeeded Mr. Fuller.

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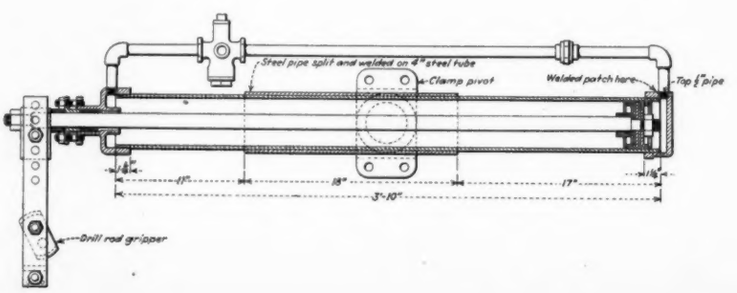
Pneumatic Drill Puller for Diamond Drilling

WITHDRAWING diamond-drill rods, employing the usual block and tackle method as practiced in the field, is a most unsatisfactory operation, as the loss of time and the extra labor required may have great effect on drilling speed and cost, writes C. S. Watt, of Auburn, Ind. To simplify and speed up this operation a neat, compact, and light, air-operated puller shown in the accompanying drawing was developed. To operate this device the puller parallel to the drill rod is held to the drill stanchion by the clamp pivot. The eccentric-shaped flexible drill-rod gripper, which is bolted onto the puller bars containing a series of $\frac{5}{8}$-in. holes to facilitate the adjusting of the gripping mechanism, is attached to the drill rod to be withdrawn. On the forward stroke of the piston the drill rod is raised automatically by the gripping action of drill-rod gripper, which on the return-stroke releases the drill rod until the beginning of the next forward stroke.



How Attention to Traffic Conditions Cuts Costs

A. L. Russell

TRAFFIC management is an important subject for every one who manages a mining or metallurgical operation. Large companies have their traffic departments, staffed by specialists, but the operator of a small property is often his own traffic manager, or at least should be. Too often, little or no thought is given to this important branch of almost any business, and many charges are incurred that could be reduced if the operator was alive to the situation and had some knowledge of what to look out for in his relations with transportation companies.

For the purpose of this article, the subject of traffic management will be divided into eleven topics, and a brief explanation of the importance of each and the attention that should be given to it by the small operator will be outlined.

1. Supervision of the packing, weighing, billing, and shipping of all outbound shipments. Freight classifications must be studied so that the shipper can take advantage of the most economical method of packing. Accurate scales should be provided so that the weight of every shipment can be known. Billings should be correct, for sometimes a slight mistake or merely an indefiniteness in the wording of a description may make several dollars' difference in the charge.

Ore or concentrates are usually the bulk of mine shipments, and they usually go to the same destination. The question of sacking is often important. For high-grade material, tight sacks that will withstand abuse are indicated. Low-grade material may be shipped loose if the cars are tight enough to prevent a loss exceeding the cost of sacking. As with all shipments, the material should be weighed. Freight rates on ore depend upon the value of the shipment, so an accurate assay is important for billing unless payment is to be made on delivery to the smelter.

2. Preparation, and presentation to the carriers, of claims for losses, damages, and overcharges. Such claims are fairly simple to prepare and file, but collection is a different matter. The loss or damage must be proved to have occurred while the goods are in the possession of the carrier, and when shipments are boxed this may be difficult. Remember that at least three agencies handle most shipments: the one which delivers the material to the railroad, the railroad itself, and the delivering transfer. A watch must be kept for overcharges, but this is often a complex problem. A technical knowledge of tariffs, classifications, and exceptions is necessary to keep one's self from being imposed upon. There is only one correct rate and rating for each shipment. The importance of watching this item is indicated by the fact that over fifty million dollars in claims have been presented against the railroads in one year.

3. Auditing of freight bills. This is preliminary to the matter just mentioned. Freight bills must be audited to find overcharges, and to have accurate data with which to meet claims for undercharges. Through either oversight or ignorance, shippers sometimes misbill goods, with the result that the rate or rating charged is higher than is legally applicable. In a recent weekly audit of an Arizona gold mine's freight bills it was discovered that a shipment of motors from Los Angeles was charged for at the rate of $1.95 when the correct rate was $1.86. Had the bill not been audited a loss of $6.75 would have been taken unknowingly. Though small, several such losses mount up. Auditing also enables the manager to make more intelligent reports and simplifies their preparation.

Schedule of Services from Los Angeles, Calif., to Prescott, Ariz.

Method	Time, Hours	Rate	Remarks
Rail freight	48	$1.86 1.58 1.30 1.12	Safest. Best for general use.
Motor truck	36	1.95 1.65 1.40 1.20	Faster than rail but not as safe. C. O. D. bond and insured.
Rail express	18	3.50	Safe. Quicker but more costly.
Parcel post	18	8c for ½ to 1 lb. 4c. each additional pound or fraction.	
Air mail	..	....	Do not use. Regular mail as fast, owing to connection at Phoenix.

4. Routing of incoming and outgoing freight. The selection of the best route and carrier for shipments to and from a mine requires diligent study, for the routes are numerous and each embraces a different rate and sometimes a different rating. Often one must choose between railroad, water, truck, and air, and combinations of these, and must consider such types as freight, express, parcel post, or air mail. A simple method of attacking this problem is to make a chart of the services available from each large purchasing center as shown in the above schedule.

A few such charts as this, the preparation of which is not onerous, will enable the manager to see at a glance all the available routes, the rates, and other characteristics of the various routes that must have been discovered by experience.

Often consideration should be given to the package car operators and freight forwarders. These companies consolidate carload shipments at eastern points, ship west under carload rates to certain breakdown points, and reship to the final destination by l.c.l. freight or motor trucks. This service saves the consignee up to 50c. per 100 lb. over straight l.c.l. shipments, with no loss of time in transit.

The various services available should also be studied from the standpoint of the maximum and minimum weights that can be used over each route economically.

An adequate library will help greatly in deciding on the routing of shipments. The following books are useful: "Bullinger's Guide," "Shippers' Guide," "Way to Ship," "Railway Guide," and a copy of the *Traffic World*. Request to the Superintendent of Documents, Washington, D. C., for a copy of Price List No. 25 will bring a list of government publications on transportation, including everything except the Interstate Commerce Commission's reports and decisions.

5. Prompt loading and unloading. This item, involving demurrage charges after a certain time, usually two days, is well understood.

6. Tracing and expediting shipments. This is a matter that can be learned only by patient study. One must be versed in embargoes, notices, permits, diversions, and reconsignments. Until such time as these can be mastered, the local railroad agent is the best counselor unless the carrier employs solicitors who can take care of this work.

7. Petitioning for lower rates or changes in classification. Such presentation before the deputized regulatory bodies requires the services of an expert. The mine manager may himself hire such an expert, or he may cooperate with others in the same field, perhaps through a trade association. The government publishes a pamphlet entitled "Rules of Practice Before the Commission in Proceedings Under the Interstate Commerce Act," which might

prove useful. Every state except Delaware has a transportation commission, but the procedure varies. One may determine local practice by writing to the secretary of the state railroad commission.

8. Cooperation with the production, maintenance, salvage, and other departments. This is of prime importance in achieving a smooth working organization. Powder, fuse, timber, and similar supplies must be delivered in time to prevent shutdowns or other hindrances to work. The tramways, railroads, and elevators must be kept in first-class condition to prevent loss of production.

9. Selection of plant and warehouse sites. Around a mine, sites of buildings are usually determined by necessity rather than choice, but sometimes there is opportunity for good judgment. Recently in Arizona a 50-ton mill was erected at a mine where two mill sites were available. One was selected because pumping of return water from the tailing dewatering tanks could be eliminated. But when the first shipment was made from the new mill it was found that a 3-ton truck could haul only 1 ton from the mill because of the steep grade. It cost $97 more for every shipment because of this, or $178 a month. Pumping of the return water would have cost only $72 a month. The perfect site was not so perfect as it had seemed.

10. Supervision of intra- and interplant movements. This involves consideration of trams, motor trucks, elevators, belts, and other means of moving freight. Though mainly supervisory, the manager's duties may involve decisions of policy or procedure. Perhaps the most important decision to be made is the economic dividing line between hand tramming and power tramming. Having decided on power tramming for certain work, the type and size of the units are of importance. Adequate records of the operation of various transportation agencies should be kept, for trucks, cars, locomotives, and other transportation devices cost money and operating conditions vary. Of particular advantage here are subscriptions to the leading technical journals of the field, which enable a manager to keep up with new developments, and to learn how others are solving similar problems in other parts of the world.

11. Keeping and submitting regular reports to officials. Reports to the officers of his corporation are more important to the manager himself than he usually imagines. These prove whether or not he is a capable man, fitted to handle the business of the company. Such reports should contain summaries of stock on hand and in transit, freight paid out, rate and rating reductions obtained, freight claims adjusted, amounts saved through consolidating operations, cartage costs, underground transportation costs, and other pertinent items.

That the maintenance of a traffic department, even if it consist of only the manager himself, may enable an operator to save money in many ways, is evident. Besides the saving, it will enable the manager to present to the investing public an assurance of a well-managed and businesslike operation that may be a decided influence should it be necessary to finance an expansion.

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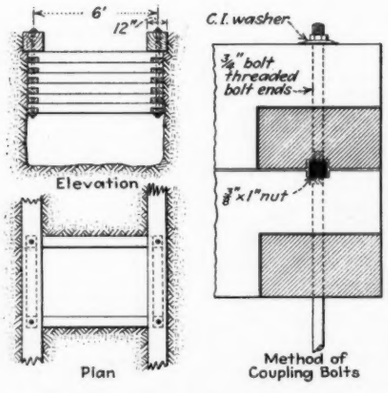
Hanging Bolts in Cribbing

USE of cribbed timbers, in place of regulation shaft sets that consist of end and wall plates and posts, is sometimes advisable for ground support in the sinking of vertical or steeply inclined headings of small cross-section, writes Alfred I. Rodriguez, of Berkeley, Calif. The setting and alignment of cribbing is a simple operation and presents no difficulty in raises, because the weight of the members acts to keep them in place on the underlying cribwork. This is not true in sinking, when considerable difficulty is experienced in keeping the timbers from falling or moving out of alignment, particularly during the firing of a round if the timbering is brought up close to the breaking face.

The following method has been applied by Mr. Rodriguez, effecting a saving in labor and insuring permanent and correct setting of the cribbing: Holes, ½ in. in diameter, are bored in the center of each tennon of timbers, as illustrated in the accompanying sketch. When the complete four-piece set is assembled, the holes on the overlying piece will conform with those of the underlying member, provided the framing and boring is done with reasonable accuracy.

Four ⅝-in. hanging bolts are suspended from the bearers in the usual manner, the bolts being spotted accurately and the diagonals checking exactly to insure alignment. When the bolts are "hung," the cribbing is readily built around them, as illustrated. The work can be accomplished by one man. Length of the bolts is governed by the number of sets that can be placed in one shift. Four nuts, under the last set and drawn up tightly on the bolts, prevent the timber from falling or moving out of position during blasting. They also safeguard men against falling timber while drilling or mucking is in progress. Where loose or running ground is being traversed and the sawn crib members are placed "skin to skin" or closely cribbed, as shown in the sketch, the timbering can be made almost watertight by drawing up the nuts.



Details of shaft cribbing

A simple and convenient union of the bolts can be effected by leaving a ⅝x1-in. nut one-half full and screwing a double-threaded drift bolt in the lower half for the succeeding sets to hang from. Where the pieces are placed "skin to skin" or closely cribbed, a 1x1-in. dap is cut out of the tennon in the bottom set pieces to accommodate the union nut.

This method of timbering, taking as example a 5x5-ft. cross-section, will require 120 ft. per foot of shaft, assuming 6x6-in. timbers are used, as compared with about 100 b.ft. per foot with regulation shaft sets, using 8x8-in. timbers, 5-ft. posts, and lagging all around. The labor required is slightly less with regulation sets, when the sinking is in hard rock. However, under some conditions the use of cribbing is justified.

Surface plant of the Great Nurupi mine, in Korea

Gold Mining in Korea

A. A. Friedman

THE Great Nurupi gold mine, of Nurupi Kozan Kabushiki Kaisha, in the northwestern part of Korea near the village of Taiyudong, is not far distant from the Yalu River, which separates Korea from Manchuria. It is 78 miles by good roads from the Japanese government railroad that traverses the Korean peninsula from north to south. This line is part of the railroad system that connects the Orient with Europe via Siberia.

The mine and surrounding area comprises the old French Mining Concession. In recent years, the properties have been acquired by English capital from the French and are now operated with the friendly cooperation of the Japanese Government. They lie at about 1,000 ft. above sea level in a rugged mountainous country. Their nearest neighbor is Oriental Consolidated Mining, 16 miles distant. About 10,000 tons of ore is treated monthly.

Essentially, the orebody is a large fissure vein in granite, comparable in many ways to the deposits of the Grass Valley district in California. The ore occurs in quartz carrying pyrite, galena, and sphalerite as the ore minerals. Free gold is also encountered in small amounts. The quartz vein varies from 1 to 20 ft. wide in various parts of the mine, strikes east and west, and dips to the south with a varying dip of from almost flat up to 45 deg. It averages about 30 deg. The orebody exhibits a remarkably strong rake to the east, which has materially affected the development program. From the original surface outcrop to where the ore has been developed on the No. 15 level, a rake of about 4,500 ft. is shown.

The entire vein is not minable, inasmuch as the commercial ore zones occur in shoots in the vein. The shoots along the levels vary from a few feet long to sometimes over 100 ft. A heavy false hanging wall of gouge matter and vein material of varying width between the quartz vein and the true granite hanging wall necessitates square-setting and then waste filling in almost every part of the mine, which has been opened to date by fifteen levels, spaced at intervals of about 100 ft. vertically. The main working shaft, the Loulou, from the surface to the No. 10 level, contains three compartments and was sunk in the footwall granite. It starts at an angle of 30 deg., steepens to 45 deg. at No. 3 level, and then to 58 deg. at No. 5 level. Three winzes to the east open the mine from the No. 10 to the No. 15 level. One serves from the No. 10 to the No. 12 level, another from the No. 12 to the No. 14 level, and the third opens the mine below the No. 14 level. At present, a new two-compartment winze is being raised from the No. 15 to the No. 10 level to supersede these three minor winzes. This winze will follow the ore down on its strong eastward rake.

The general method of mining as employed on the lower levels is to sink in the channel. When the level interval is reached, a station and pocket are cut and drifting both east and west proceeds on the ore, always breaking the drift to the false hanging wall. After a shoot of ore is opened up by drifting, a raise is run in the ore to the level above, following up on the footwall. This raise facilitates ventilation and serves as a waste passage for stope filling obtained from development headings on the level above. A stope is next cut by taking the first horizontal slice along the length of the oreshoot, square-setting, and then waste filling as mining proceeds.

Chutes are arranged on the level at about every tenth set, which is not filled but serves as a manway and ore pass. Mining now proceeds in horizontal slices, square-setting, and then waste

The Nurupi mine settlement, showing roads and tram line from mine to mill

filling until the level above is reached by the advancing stope. Of late, the practice of cutting a sublevel midway between the main levels has been adopted. This gives two minable blocks of ore instead of one block, and cuts down the distance that broken ore must be slushed on the flat footwall from the working face to the level.

All broken ore is sorted in the stopes by the native coolies, who bend over the muck pile with a small hand grub-hook and a clamshell-shaped basket made of heavy woven straw, holding about 20 lb. ore. The waste is thrown behind them as fill for the mined-out sets and the ore is cast into the open chute set.

On each level, the footwalls and hanging walls are prospected every alternate 100 ft. by crosscuts, in the hope of picking up a parallel vein or a small split, often hidden by a selvage of gouge or vein matter. Crosscutting is terminated when the true, hard granite footwall or hanging wall is reached.

The Loulou shaft is equipped with a double-drum, electric-drive hoist. Two 2-ton skips operate in counterbalance in this shaft. Each of these dumps into its own pocket, about 20 ft. below the shaft collar. An adit drift, driven into the hillside about 40 ft. vertically below the collar, extends under these pockets. One and one-half ton cars are loaded from them and trammed down to the mill. By this arrangement, plus a set of sheaves and two sets of small rollers erected on bents between the shaft collar and hoist house, no need exists for a gallows frame and the accompanying surface bins. Two of the underground winzes are provided with single-drum, electric-drive hoists using a 1½-ton skip. The third winze, starting on the No. 14 level, is equipped with a compressed-air hoist.

Formerly the company generated its own power with a charcoal-burning plant. Following much unsatisfactory service rendered by this plant, a steel-tower transmission line, more than 100 miles long, was erected. This line carries power from the Japanese-operated generating stations near Pyeng Yang to the mine. It has provided steady and efficient power.

Although the mine itself does not make an undue amount of water, considerable anxiety is caused during the rainy season by seepage through the outcrop. For this reason, should power service be temporarily interrupted along the line because of a heavy storm, steam boilers are held in readiness to operate pumps serving the sumps on the upper levels that are most quickly filled during the rainy season.

Drilling is done with Ingersoll-Rand Jackhamers, each manned by two native miners. In a few outlying places, hand drilling is resorted to. Air is furnished by two Ingersoll-Rand compressors.

From 500 to 700 native Koreans and Manchurian Chinese are employed underground, at an average wage of about 40c. in gold per eight-hour shift. Development and mining work is let out to native contractors at set rates per foot and ton, depending upon hardness, accessibility, and other factors.

Each contractor has one or two subbosses on each shift who help him to supervise one shift. The company employs one native shift boss on each shift to supervise the day's pay men underground. Foreign labor supervision consists of the mining superintendent and three shift foremen, each of whom is responsible for all mining operations during his shift.

All development and stope faces are carefully and systematically sampled. Stope faces and their corresponding assay values are plotted in a sample book, the use of which makes possible positive control of the grade of ore sent to the mill. Estimation of ore reserves from the daily sampling results is made every quarter.

The native Korean is a good miner, docile and resourceful. As a timberman he is hard to surpass. Although not as yet a master of the pneumatic drill, he shows himself as an excellent hammer man. Locally, the Manchurian Chinese has proved the best trammer.

Mine timbers are framed on the surface. Round timber in the required lengths and diameters is supplied by contractors from the native forests of Korea, often many miles away.

Several hundred tons of high-grade lease ore are also milled each month. This is mined by native tributers on the concession. The tributer produces a high-grade ore solely because of his ability to sort closely after breaking his product to about ½-in. This plan has also provided excellent means of prospecting the concession.

The ore is milled in a 50-stamp plant, followed by concentrating tables, flotation, and cyanide. Gold and silver bullion, carrying a minor amount of silver, is produced. Some concentrate is also shipped periodically to the smelter on the west coast.

As the mine is about 78 miles over mountain roads from the railroad, transportation was a problem. This has been solved by the use of trucks, which daily ply between the mine and the railroad station at Reibi. Little trouble is experienced by the trucks during the winter snows, but heavy summer rains often cause delays in the delivery of supplies to the mine. Some supplies not urgently needed are delivered by carts and sleds. Almost all the mine timber, representing the bulk of material delivered to the property, is also hauled in on ox-drawn devices. Efficient service by Imperial Japanese Telegraphs gives prompt communication with the outside world.

Although the foreign staff hardly totals a dozen individuals, recreation is provided in the local Taiyudong Club rooms by bridge, billiards, musical entertainment, and a large library. Motion pictures are shown about twice a month. Social functions are periodically exchanged with the Unsan Mines Club of Oriental Consolidated Mining, the mine's near-by neighbor.

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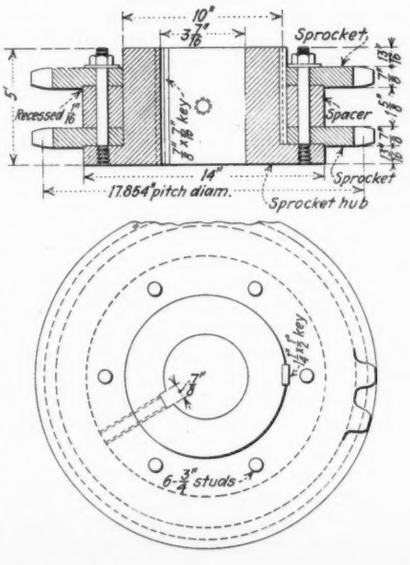
Novel Conveyor Drive

RAISING the conveyor speed to increase the capacity of the crushing plant caused trouble with the conveyor-chain drives, writes F. J. Martin, master mechanic of Miami Copper, Miami, Ariz. The higher belt speed increased the load on the drive mechanism, and affected the life of the chains proportionally. This made necessary the installation of more powerful drives, or remodeling of the ones in use. The latter method was selected on account of the lower cost. It was accomplished by replacing the single chain with a double chain drive and the novel twin sprockets shown in the accompanying drawing. Each unit consists of a hub, with two bolted-on sprocket disks, and a spacer, all made of cast steel. The 1¼x½-in. key and the ⅛-in. recess on each sprocket afford additional stability and insure perfect alignment of the two sprockets.



Iron Mining in Cumberland, England

Lucien Eaton

FOLLOWING the shore line on the northwest coast of England is a belt of sedimentary rocks in which hematite iron ores have been mined for several hundred years. This is the Cumberland and Lancashire iron district, and the productive area extends from near Whitehaven, in Cumberland, on the north, to Ulverston, in Lancashire, on the south. Sporadic deposits of ore have been found and mined in the Lake Country further inland, and ore was formerly worked extensively between Whitehaven and Kelton, at the north end of the district; but these mines are now closed.

The mines are situated in a charming district of rolling hills and green valleys. At one time the country was heavily wooded, but most of the timber was cut off more than a hundred years ago, and the land is now used largely for grazing. There are plantations of larch in the Lake Country to the East, and this timber was extensively used in the mines a few years ago, but now the principal source of supply is Ireland.

A visitor to the district should stop at the Furness Abbey Hotel, at Furness Abbey, when visiting the mines in the southern part of the district, and at the Skawfell Hotel, at Seascale, when visiting the northern mines. A network of bus lines makes it easy to get within walking distance of the mines. Accommodations are excellent at both hotels, and there are good golf courses close by for recreation.

The hematite ores of the district have been mined from early times. Possibly they were worked by the early Britons, and evidence exists that they were mined by the Romans or the Norsemen. "The earliest authentic record[1] of mining is the account of an iron mine in Egremont parish, in Cumberland, that was granted, together with a forge, to the Abbey of Holme Cultram in 1179." Furness Abbey was founded in 1127, and the monks there worked the ores prior to 1235. Probably the first important mine was that opened at Stainton in 1523. The Bigrigg mine, near Egremont, in Cumberland, was opened in 1635, and is still running, and possibly this was the mine referred to in the foregoing as having been worked in 1179. At Millom, ore was mined in 1690, and the famous Hodbarrow mine there is still working. Discoveries have been made intermittently until recently, and opportunity still exists to discover more ore. In the northern district, particularly, one is struck by the similarity to the central part of the Marquette iron range in Michigan, where in the early days many small mines were opened in the area where the iron formation was exposed by erosion and where the largest ore deposits have been found in much later years under heavy cover.

Wyndham pit, Bigrigg

At first the ores were worked in hearths, and later in forges and bloomeries, using charcoal for fuel and making wrought iron. The last of these stopped work in 1880. The first blast furnace was built at Backbarrow village in 1711, and the use of smelting furnaces increased from then on. Ore was shipped by water to Scotland as early as 1727, to be used in charcoal furnaces. It is now smelted in furnaces at Barrow, Millom, and Workington, and is shipped to furnaces in the Midlands.

The ore is a hydrated hematite, rather high in iron and very low in sulphur and phosphorus. In some of the ores the silica is high, and in others some of the silica is replaced by lime. The ores now being mined contain 50 to 56 per cent iron (dried), 12 to 15 per cent silica, 0.010 phosphorus, and 0.007 sulphur. Selected lump ores for use in the open-hearth furnaces run as high as 60 per cent iron, and have only 1½ per cent moisture.

The ores occur as replacements in Carboniferous limestone. Ore deposition has been influenced largely by faulting and possibly by the shale bands interbedded with the limestone. The latter, which attains great thickness in places, overlies the older Skiddaw slates and Borrowdale volcanics, which form a basal complex, and is overlain in turn by a conglomerate, or "brockram," made up largely of detritus from the older rocks. The conglomerate is of Permian age, and rests unconformably on the ore-bearing limestone. An unconformity likewise exists between the limestone and the underlying slates and volcanics.

Two systems of faults occur, one with a west-southwest and east-northeast trend, which does not cut the overlying conglomerate, and hence is pre-Permian, and another system with a north-northwest and south-southeast trend, which cuts all strata and the older faults as well, and is post-Permian. The ores are apparently later than either set of faults.

In the northern part of the district the ores occur in veinlike bodies along faults; in "flats," which are orebodies of considerable horizontal extent, following the bedding more or less closely; and in "guts," orebodies connecting "flats," or extending downward, like "gash-veins," in the limestone below the more widely mineralized zone.

In the southern part of the district some veins and some large, irregular bodies occur, but the most characteristic deposits are the "sops," described[2] as "bodies of ore, circular to oval in plan and narrowing downwards like deep basins or pockets in the limestone." Some of these are very large, and, indeed the custom locally seems to be to refer to all large, irregular orebodies, even "flats," as "sops." The southern ores are in general much softer than the northern ores, and require more timber in mining.

Some difference of opinion is expressed in regard to the origin of the ores and the date of their deposition. J. D. Kendall,[3] who made a thorough study of the district in the latter part of the last century, thinks they were formed in pre-Permian times by ascending waters, which replaced limestone in

[1] "Haematites of West Cumberland, Lancashire, and the Lake District," p. 1. By Bernard Smith, Sc.D. The geological and historical data are largely taken from Mr. Smith's report.

[2] Bernard Smith: *Op. cit.*, p. 9.

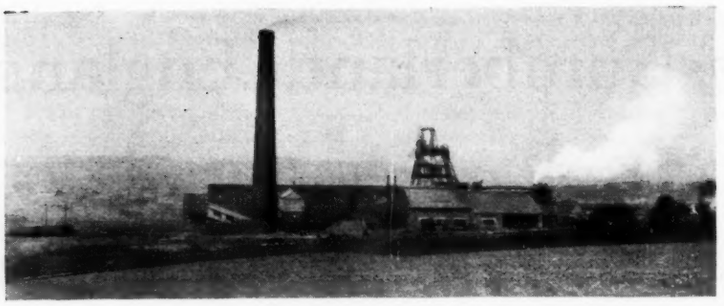
[3] J. D. Kendall: "Iron Ores of Great Britain and Ireland," 1893.

[4] Bernard Smith: *Op. cit.*, p. 40.

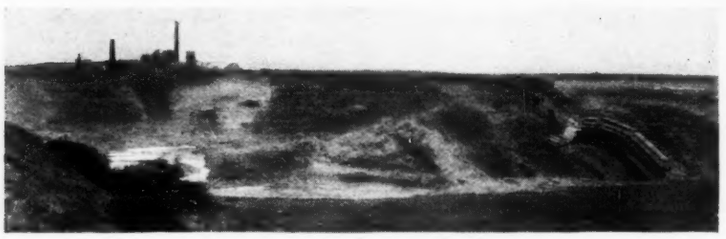
[5] E. E. L. Dixon and Bernard Smith: "The Origin of Cumberland Hematites." Summary of Progress of the Geological Survey of Great Britain for 1927. Part II. Pp. 23-37.

[6] Imperial Mineral Resources Bureau. Iron Ore. Part I: United Kingdom. 1922; p. 157.

[7] Bernard Smith: "Haematites of West Cumberland, Lancashire and the Lake District"; p. 77.



Florence mine, Egremont



Hodbarrow mine, Millom

place along existing zones of weakness.

Bernard Smith,[4] who made a study of the district during and after the Great War, thinks they were formed in post-Triassic times by descending waters, replacing the limestone as Mr. Kendall states, and that the source of the iron was the everlying red sediments.

E. E. L. Dixon[5] in 1927 upheld the theory of ascending waters, basing his theory on the presence of veins of hematite in the pre-Carboniferous slates in the Lake District, and on the presence of fluorspar and barite in the orebodies in the limestone.

The extremely low sulphur content of the ores, less than 0.01 per cent, the presence of broken limestone, only partly altered, below the ore in many places, and analogy with other occurrences of hydrated hematite ores, all suggest that the theory of descending waters is correct. The absence of dikes in the orebodies or near them is another argument in favor of this theory.

A difference of opinion exists also as to the source of the iron-bearing solutions, one opinion being that it was the red sediments, and another that it was the Skiddaw slates. The Red Beds and sandstones are both topographically and geologically higher than the carboniferous limestones in which the ore occurs, whereas the slates are geologically lower, but are now in places and were in Permian times higher topographically than the fringe of limestone on their borders. This is proved by the fact that the conglomerate, or brockram, overlying the ore-bearing limestone, is largely made up of fragments of the slates and volcanics of the basal complex. That the iron may have come from the slates seems entirely possible; also that the iron-bearing solutions flowed over the limestone at about the time the brockram was formed, and that the veins of hematite in the slates themselves are either relics of the original source of supply or the result of concentrations similar to those that went on in the limestone. The presence of hematite pebbles in the conglomerate tends to confirm this assumption.

Deposition of the ore is probably going on at present, iron from the upper horizons being dissolved and redeposited lower down, but the action is too slow to be measured by the means at our command.

Top-slicing, which had its origin in these mines, has been almost universally used in the southern part of the district. One mine, however, has now changed to bottom-slicing with sand-filling. In the northern part, where the ore is harder, the pillar-and-stall system is used, leaving a "middling," or floor, between sublevels. Pillars and middling are recovered on the retreat. Comparatively little timber is needed. In one mine, where large open stopes were mined between pillars, the stopes have been filled with sand, and preparations are being made for mining the pillars by bottom-slicing with sand-filling.

In general, mining practice may be said to follow closely that employed in the neighboring coal mines, but the equipment used is smaller. With few exceptions the ore is trammed in half-ton buggies, and is hoisted on small cages in balance. Some tramming is done by hand and some by endless-rope haulage or electric locomotive. Pumping is done largely with Cornish pumps with two rods in balance, but the later installations have been electric.

All shafts are vertical, and the older shafts are rectangular and small in cross-section and are timbered with 4-in. pine. Some of the newer shafts are more heavily timbered, and are larger in section, and the latest to be sunk, the Moor Bank of the Hodbarrow Mining Company, at Millom, is circular in section, 16 ft. in inside diameter, and is lined with cast-iron tubbing and concrete. It is, I believe, the first in the district to be equipped with skips. In sinking it the company has done an excellent job under trying conditions.

Individual power plants are the rule, one plant for each shaft, burning coal in Lancashire boilers, but an electric power company has extended its lines into the district, and a change to electricity in the near future seems likely. This should be a boon to the mines operating on part time.

Water is the curse of the south end of the district. Here some of the mines have had heavy flows, and, when they have closed down, their neighbors have had to handle this water as well as their own, which is a great burden when operating on a small output. Not all of the mines are connected, even by watercourses or seepage, and some of the heavy flows seem to have been bottled up, for the time being at least. In the north end the flow of water in individual mines is not large, and only by closing of several contiguous mines does the burden become heavy.

During the war the mines were worked intensively, and in 1918 30 were in operation, giving employment to 6,775 men, and producing 33,000 tons of ore per week.[6] The number of mines working has decreased gradually until now only three are running in the southern part of the district and seven in the northern part.

The southermost mine now operating is the Newton, near Dalton-in-Furness, operated by the Newton Mine and Quarry Company of that place. The orebodies are veins in limestone, and the ore is mined by top-slicing. Output is not large at present.

The Anty Cross mine, at Dalton-in-Furness, has been definitely abandoned by the lessors, the Barrow-Hematite Steel Company, Ltd., who have given up the lease. In this mine there was an interesting occurrence of rich copper ore in the hematite. Several hundred tons was sorted out and sold, but the copper left in the hematite injured its marketability. This mine had a heavy flow of water and was not opened to great depth.

Roanhead mines, between Dalton and Askam, are being operated by Kennedy Bros., Ltd., of Ulverston. Their Nigel No. 2 pit is working a "sop" not far from the old Park mine, now abandoned, a property that produced over 9,000,000 tons of ore. The mines are close to the seashore, and have a fine view over Duddon Sands toward Millom. The ore is a rubbly, hydrated hematite with a considerable percentage of lumps of steel ore and kidney ore, which are sorted out by hand for use in the open-hearth furnaces, the remainder being sold as "blast ore."

The orebody is irregular in outline, and is overlain by "pinnel," or brecciated limestone, gravel and clay. A

"skin," or layer of clay also occurs between the ore and the surrounding limestone. The ore is mined by top-slicing, levels being 75 ft. apart. The shaft is 500 ft. deep. Unfortunately, this mine has inherited a large flow of water from the adjoining Park Mines, and the pumping charge must be a heavy burden for a reduced output. At present 2,000 tons a week is being produced, but the mine is capable of a much larger output than this.

On the north side of Duddon Sands close to the town of Millom is the famous old Hodbarrow mine. Here a large deposit of soft hematite has been worked for over 100 years, and more than 22,000,000 tons of ore has been produced. The orebody is a great sop in the limestone, and is overlain by water-bearing sands and clay. It is close to the seashore, and was formerly protected by a great sea wall. The ore was found to extend under this, and another wall was built outside again at a cost of approximately half a million pounds. The main body of the ore, which was about a thousand feet wide and seventy thick, has been exhausted, but outlying irregular deposits remain to be mined, which will undoubtedly yield a large tonnage. To mine one of these the new Moor Bank shaft has been sunk.

The ore is a hydrated hematite, containing nodules of kidney ore, grape ore, and steel ore, and averages about 55 per cent iron, although some is as rich as 60 per cent. On account of its physical and chemical properties, it carries a premium in the market. Most of it is smelted in the company's furnaces at Millom.

Most of the ore in this mine was mined by top-slicing, but this has been changed to bottom-slicing with sand-filling. Sand from the seashore is used for filling, and is sluiced into the mine through pipes in boreholes or in the shafts, and is distributed to the working places through pipes. Jets of compressed air are used to assist the flow and keep the pipes clean. The sand is confined in the slices with brattice cloth, through which the water drains. Careful blasting does little damage to the cloth and prevents contamination of the ore by the sand, and support by the sand is almost perfect. The problem would be simpler if the upper part of the orebody had not been mined by top-slicing.

The Moor Bank shaft was sunk under great difficulties. Near the surface water-bearing sand and clay occurred, and below that broken limestone, containing water and running mud, which was very difficult to handle. By the use of the cast-iron tubbing, working through this ground was possible, and cementation was used to seal off the water. The work was under the charge of a Belgian firm of engineers. The mine is being worked on a reduced schedule, and is producing about 3,500 tons per week, part being stocked.

In the northern part of the district the mine farthest south is the Beckermet mine, at Beckermet, formerly called the Winscales. It is operated by the United Steel Companies, Ltd., of Workington, under the management of Langton Highton and his assistant, Charles Booth. The two shafts, some distance apart, are 1,250 and 1,450 ft. deep, respectively. At present, operations are being concentrated at the more southerly shaft, No. 1, as the ore trends in this direction. Two diamond drills are in use, boring from surface at this end of the property.

The ore is a fairly hard, brown hematite, carrying 48 to 50 per cent iron, and is high in lime. The occurrence is as an irregular flat, seldom more than 50 ft. thick but of great horizontal extent. This flat is influenced by both sets of faults, previously mentioned, but is apparently not cut by them. The ore occupies the fault plane in the offsets between the level parts of the flat. At this point the overlying cover of limestone and conglomerate, or brockram, is very thick, and a bed of limestone lies under the ore, and under that the volcanic ash.

The ore is mined by pillar and stall in sublevels 20 to 25 ft. apart, a "middling" being left between sublevels. The pillars and part of the middling are recovered on the retreat without timber, before the remainder of the middling comes down, for the ore stands remarkably well. The remainder of the middling is recovered with timber.

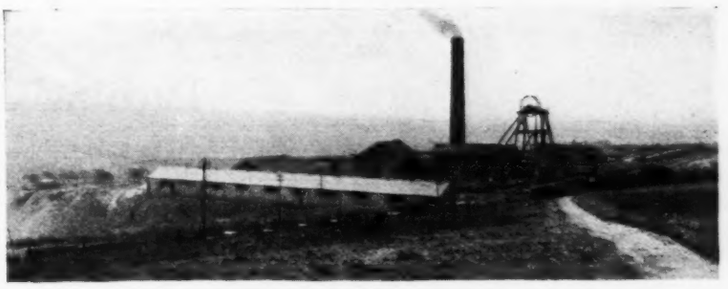
No. 1 shaft is working six days a week and is producing about 4,000 tons a week. Very little is being done at No. 2 shaft.

This company has recently closed the old Woodend mine, north of Egremont, but is still pumping. It is working the Sir John Walsh mine, adjoining the Woodend mine on the north, and from this shaft is working the Parkhouse mines further north. Two old orebodies are being cleaned up, and a new one is being opened. Mining is by pillar and stall, but some of the old workings have caved, and the ore is being recovered on timber. In character, the ore is more like that in the Millom district. The output at present is about 1,400 tons a week.

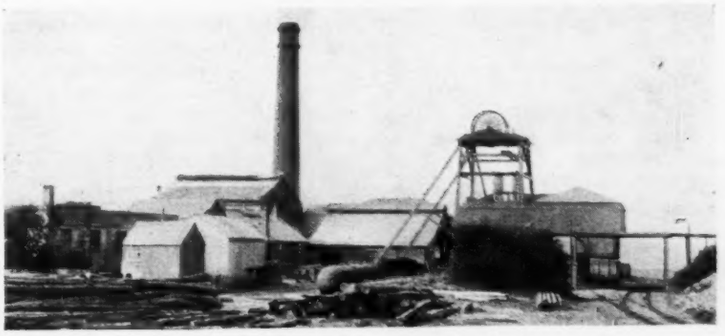
Adjoining the Beckermet mine on the north is the Florence, the newest in the district. It has one shaft and a centralized plant. The potential output is greater than that of any single shaft now operating in the district, but the mine is working only three days a week.

The deposit is the upward extension of the Beckermet orebody, and consists of a large flat, varying in thickness from 30 to over 100 ft. This ore connects with the flat of the Ullcoats mine on the north, and forms with the Beckermet and Ullcoats orebodies the largest deposit that has been found in the district since the great Hodbarrow mass was found. It is estimated to contain over 20,000,000 tons of ore, and its total extent is about 90 acres. The ore is similar to that at Beckermet, but higher in iron and silica.

The shaft is circular in cross-section, 17 ft. inside diameter, and 1,014 ft. deep. It was started in 1914 and reached the ore in 1920. At this mine the ore is mined by pillar and stall, a small middling being left between sublevels, which is recovered with the pillars on the retreat. The mine has probably the



Beckermet No. 1 shaft, Beckermet



Beckermet No. 2 shaft

Park mine, Dalton

Woodend mine, Bigrigg

most complete mechanical equipment in the district.

The Ullcoats mine, adjoining the Florence on the north, is operated in a small way by the Ullcoats Mining Company, of Whitehaven. It has two comparatively shallow shafts, from which two flats and a veinlike orebody connecting them have been worked. The ore is of the same character as at the Florence.

In the Bigrigg-Cleator Moor district, 1 to 2 miles north of Egremont, four shafts are operated by Lord Leconfield's Haematite Iron Ore Mines, of Whitehaven, under the management of Frank Ahier. At Bigrigg are the old Wyndham pit and the Croft pit, and close to the former is the old open pit, where ore was mined in 1635. Both shafts now operating are old, and the hoist at the Wyndham is said to have been built in 1860. It is a double-drum hoist, geared to duplex, horizontal, slide-valve engines, and runs as smoothly as if built last year.

The ore occurs as flats and irregular bodies in the limestone and as veinlike bodies along the faults. Near the Wyndham, there was formerly a huge irregular orebody up to 220 ft. in thickness, but this has since been mined. At present the Wyndham is working daily on day shift only, and hoisting is done at the Croft pit only three days in two weeks. Mining consists of robbing pillars and scramming. The output at present is 1,000 to 1,200 tons per week.

In Cleator Moor are the York pit and the Crowgarth mine of the same company. The latter is being worked in a small way, robbing pillars.

At the York the ore was about 50 ft. thick, and stood well. Large rooms were mined, up to 60 ft. in width, and when these were finished, they were filled with sand. Some of the pillars have been recovered, but many of them cannot be touched, or can be only partly mined, because the ore lies under the village, and surface rights and buildings are not owned by the mining company. The work at present consists of development under some of the available pillars, which are to be mined by horizontal cut-and-fill. A large face of ore remains untouched in this mine, because it lies too near the surface to permit its mining without danger to the buildings above it.

Of interest are the little mining villages, like Cleator, with their long rows of connected, stone houses, the front doorsteps flush with the narrow sidewalks, and all about them broad green fields, unoccupied except by a few cattle. It seems like a perversity of fate that some of these villages should have been built over some of the best ore. In summer they are not unattractive, but in winter, when everything is cold and wet, they are dismal places; yet the men and women who were born there hate to leave them, now that the mines are closed, and prefer to continue to live there on the dole, rather than take employment elsewhere.

Not all of the mines were closed because the ore had been exhausted. The depression is due rather to competition by cheap Spanish ores and to high freight rates charged to the furnaces in the Midlands. With cheaper freight rates and lower mining costs the mines of the district could be worked profitably for years to come.

Even though production is now at low ebb, a visit will be found both pleasant and interesting. Visitors are most hospitably received at most of the mines, especially if one has taken the precaution to obtain letters of introduction or at least of identification. To those who are interested in iron mining and its history the district should have a special appeal, for the influence of the men who have migrated from it has been felt in mining camps in all parts of the world, wherever they have gone.

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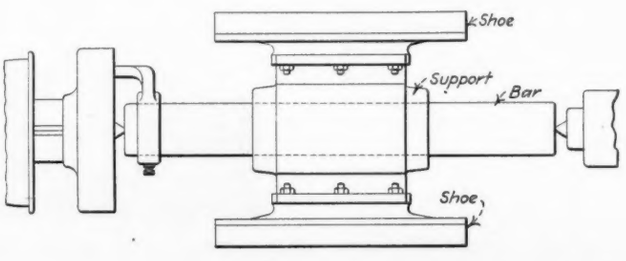
Turning Crosshead Shoes

MOVING PARTS of engines, to be interchangable, and in order that fitting with rasp and scraper may be avoided must be machined with precision. Although, turning of bearings is a comparatively simple matter, the machining of crosshead shoes in the lathe often presents a problem, writes F. R. Kennedy, master mechanic, Old Dominion, Globe, Ariz. To solve this problem successfully, a special lath set-up must be used, as, for instance, the method illustrated in the accompanying sketch. Here, the shoes are bolted to the sides of a machined mild-steel support, mounted on a carefully centered bar resting between the live and dead centers of the lathe. As dimensions of the support correspond to those of the crosshead body, no further adjustments to the shoes are necessary, and turning operations may commence immediately following the application of the lathe dog.



Technical Application Of Practical Unemployment Relief

A MOST HELPFUL and practical program of relief of the current unemployment conditions has been promulgated by the Wheeler Committee on Employment Plans and Suggestions, in Chicago. The Wheeler Committee is a subcommittee of President Hoover's national relief organization headed by Mr. Walter Sherman Gifford, president of the American Telephone & Telegraph Company. From a detailed consideration of the broad problem of relief, which is accompanied by emphatic protest against the often cruel, unnecessary, and inhuman slashing of salaries and reduction of forces, which, the committee declares, aggravates and intensifies every evil from which industry in general is suffering, ten specific indices of sensible, practicable, and effective procedure are set forth. Summarized and condensed, these provide for, specifically:

1. Resumption of normal buying by individuals, industry, and governmental agencies.

2. A return of hoarded money to the service of industry and society.

3. Expansion of basic credit facilities as advocated by President Hoover. In this connection bankers and financial institutions are urged to give due weight to intangibles in extending credits. Among these are, of course, good will and the reputation of the borrower, and the sagacity and integrity of management.

4. Spreading of available work in industrial, commercial, and professional enterprises. This emergency expedient is especially worthy of study by employers. The report says: "Workers have generously shared hours of labor —but a large number of employers have not responded."

5. Cooperation of men and women in federal, state, and local public service, especially the civil service groups. Though many of these have subscribed liberally to relief funds, little has been done by the classes named toward a definite objective having for its purpose a greater spread of available work. In many vocations such a spread is entirely feasible.

6. Cutting red tape and routine hindrances to starting immediately on public works already authorized and for which appropriations are available.

7. Part-time employment, especially for the benefit of the vast numbers of so-called "white-collar" classes, the distress of which is often more acute than that among industrial workers.

8. The report declares, "In making effective the spread of employment, consideration should be given by every unit of industry to the capacity of each individual employee for self-help and to his personal and community responsibilities."

9. Community and district surveys to determine the extent of "made" work, of all kinds, that may be available. Certainly work that has been "put off," for whatever reason, should be done *NOW*. If it be necessary and sound economically and industrially, credit and funds for its initiation should be available under contemplated financing programs.

10. Transfer of idle city labor to farms as an emergency measure, on a work-for-keep or other basis.

A further recommendation may well be added: provision of cheap and expeditious transportation of workers from one region of seasonal employment to another.

The following news item presents a practicable and efficient way for corporations and business organizations to assist materially and effectively in unemployment relief:

I-T-E Puts Its Shoulder to the Wheel

The President's Organization on Unemployment Relief, under the able direction of Walter S. Gifford, provides the machinery for the intelligent relief of the needy in the hard winter that now faces them.

Money is the power needed to run this machinery, and the I-T-E Circuit Breaker Company will do its share in this manner.

Two per cent of the gross sales of this company for November, December, January, February, and March will be donated to the relief organizations of the communities in which these sales originate. No order for less than $100 will be included in this plan. Our prices are published and will not be modified.

We have deposited with the Fidelity-Philadelphia Trust Company a special fund of $25,000 from which within ten days after the receipt of each order a check will be on its way to help the relief work.

Our voluntary donations to relief organizations all over the country will be in addition to our donations for local relief. It is naturally our hope that other members of the electrical industry, as well as other industries, may be led to adopt this plan or a modification of it for supplying the money needed to ameliorate the condition of the nation's unemployed. Our shoulder is to the wheel—many more shoulders are needed.

I-T-E Circuit Breaker Company,
Philadelphia, Pa.

To meet those emergencies that are created by the imperative and irremediable necessity of reductions in personnel, the Wheeler Committee has evolved a formula that takes into consideration the social and civic aspects of the situation, as well as those of an industrial or corporation character. The formula, designed to meet the emergency with the least possible harm and suffering, is as follows:

In laying off or hiring labor, of whatever kind, or in spreading labor, preference should be given, in order, as between equally efficient employees and workers, to—

1. Married men with dependants, residents in the community six months or more;

2. Single men or women with dependants, similarly resident;

3. Single men or women, above school age without dependants but with no other means of support, similarly resident.

This suggestion appears to provide the ultimate of justice and decency possible under conditions that are in and of themselves desperately unjust and cruel to all concerned.

The Wheeler Committee condemns with especial vehemence the "gross injustices perpetrated on individuals, with harm to business generally and to the public welfare, through the deliberate elimination of old employees, solely for economy. These men, representing in accumulated experience and proven service a definite asset to business and to the public, have been dismissed so that juniors with smaller salary could be substituted. There are clear instances in which conditions arising from this depression have been made the excuse, for purposes both selfish and inhuman, to dispense with the services of men who have grown old and who have earned their right to continued employment."

Probably no other policy of mismanagement is so completely immoral as that condemned in the foregoing. Its practice connotes an inefficiency even exceeding its shortsightedness and cruelty. To be able to record the fact that the mining and metal industries have for generations been considerate of the "old-timer" is a source of satisfaction.

We commend to our readers the fine example of the I-T-E Circuit Breaker Company and we bespeak most earnestly all possible cooperation in effectuating, within the immediate present, the program and objectives of all committees for emergency relief, national, state, and local.

Personal Notes . . . Comment . . . Criticism

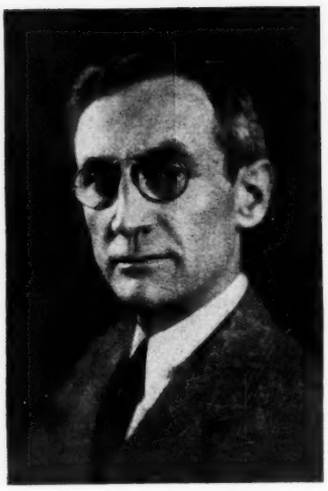
J. M. Hill, Alaska Division, U. S. Geological Survey, is in Washington, and expects to remain there until shortly before Christmas.

E. H. Crabtree, superintendent of National Exploration's Midnite Test mine, near Prescott, Ariz., has resigned. His successor has not yet been announced.

Robert F. McElvenny, Western smelter manager, and **William P. Lee,** metallurgist, of American Smelting & Refining, arrived in Australia at the beginning of October to confer with the Mount Isa Mines staff.

H. C. Henrie, manager of the labor department of the Copper Queen branch of Phelps Dodge, has been appointed director of relief work for Cochise County. As director of unemployment relief work he succeeds Cleon T. Knapp, who resigned recently.

John C. Pate, mining engineer with Chile Copper, at Chuquicamata, Chile, is now on leave, and is visiting in the Coeur d'Alene district, where he was formerly on the staff of the Morning mine of Federal Mining & Smelting for several years.



DR. H. C. PARMELEE

Dr. H. C. Parmelee has been elected a vice-president of the McGraw-Hill Publishing Company. Doctor Parmelee has for some years been editorial director of the company. His previous posts include the editorship of *Chemical and Metallurgical Engineering* and the presidency of the Colorado School of Mines.

Arthur W. Burgren, mining engineer, who has been employed by American Smelting & Refining in Mexico for the past 19 years, and for many years as superintendent of several of that company's mining units in that country, has left Mexico and is making his home in California. Mr. Burgren's address is P. O. Box 421, Los Banos, Calif.

J. T. Potts, former sales manager of the Hewitt Gutta Percha Rubber Company, of Buffalo, N. Y., and for many years connected with that company in Salt Lake City, has been elected president of the Galigher Company, of Salt Lake City, dealers in mining machinery and supplies. He succeeds the late J. E. Galigher. **J. F. Geary,** mining and metallurgical engineer, becomes a member of the staff of the company.

Carl F. Witham, president and general manager of the Nabesna Mining Corporation, Chitina, Alaska, is in Seattle, buying equipment for his company's mine. He reports ". . . a very successful season last year, considering that we had to build our mill plant, water system, and camp buildings. We got out 35 tons a day, the mill starting operations July 1, and running 708 hours before shutting down for the season. Concentrate produced was sent to the Tacoma smelter."

Among contributors to this issue:

A. A. Friedman (College of Mining, University of California) has held the positions of mine surveyor, Engels Copper Mining, California; chief mine engineer, Hammon Copper, Arizona; mine foreman, Nurupi Kozan Kabushiki Kaisha, Korea. Mr. Friedman is now on the staff of Searchlight Gold Corporation, Nevada, as mine engineer.

Lucien Eaton, who recently returned from London, where he occupies the position of consulting mining engineer on the staff of Rhodesian Selection Trust, was formerly with the Cleveland-Cliffs Iron Company, for many years as superintendent of the Cliffs Shaft mine, at Ishpeming, Mich.

James B. Chamberlain until recently was on the staff of the Araca Tin Company, bringing back to the United States much data on geological conditions in Bolivia, particularly in regard to the Araca deposits.

A. L. Russell is traffic manager for National Exploration Corporation, Prescott, Ariz. Previously, Mr. Russell worked for a few years underground and in the mill. A study of traffic management was aided by previous experience in trucking. As a result, he was able to offer a plan for operating a traffic department, for acceptance contingent on savings effected. The merits of the proposal were demonstrated, and he was given charge of the department.

The Howey Gold Mill

To the Editor:

In my article entitled "Cyaniding 40-Mesh Pulp at Red Lake, Ontario," in a recent issue, I credited the design and construction of the Howey mill to the Canadian representative of General Engineering Company, who secured the contract. As this does less than justice to the men on the ground, I shall be obliged if you will publish the following additional statement:

Following a series of laboratory tests in Salt Lake City and elsewhere, General Engineering Company contracted to build the Howey mining and milling plant, Howey Gold Mines to purchase machinery and supplies and pay all labor, and General Engineering to provide the services of F. C. Torkelson as chief engineer and Paul C. Schraps as metallurgist. These two designed and erected the plant, subject to the approval of the general manager of Howey, Horace G. Young, and the arrangement proved entirely satisfactory to both companies. Mr. Schraps operated the plant for two months after completion, when it was turned over finally to the Howey management.

W. M. Goodwin.

Ste. Anne de Bellevue, Que., Canada

Standardization of Screening Data Urged

To the Editor:

In a recent editorial you pointed out the need for more data on the cost of grinding, per ton of ore, through a certain size sieve. Accurate data on this subject would be valuable, but when one considers that the method of making screen analyses at the various plants is not standardized, and that the screen analysis of the same sample may vary as much as 20 per cent by using the different methods, it is obvious that cost data from a number of plants cannot be correlated accurately without making some correction for the sieving method. Unfortunately the discrepancy due to incorrect methods is greater on fine pulps than on coarse samples like ball-mill feed, and therefore the data are not relative for feed and product of a grinding unit.

If a standard method were adopted each plant could run a series of comparative analyses, checking its own method against the standard. This would give a correction factor for each individual type of sample. Old data could then be corrected by these factors, and one variable would be removed.

Mr. Alan Probert's article in a recent issue presents an interesting discussion of this subject.

C. E. Bartlett,
Assistant Mill Superintendent,
U. S. Smelting, Refining & Mining.
Midvale, Utah.

Top-Slicing and Timber Recovery

To the Editor:

The top-slicing method described in the following and illustrated in the accompanying drawing is offered as a suggestion. It has not yet been tried. With modification of details that may be worked out in practice it may prove effective in lowering costs of timbering on top-slice stoping without decreasing safety.

By referring to the drawing, one will note that the floor of the slice is placed at a slight inclination to the horizontal from the back wall to the front wall of the stope. The stulls stand vertically on wedge-shaped foot blocks, the wedge angle being the same as the inclination of the floor, so that the top of the block will be horizontal. A hook bar is set into the floor in front of the foot block to keep it from sliding down the incline. The head block should also be wedge shaped. The inclination of the floor shown is about 10 deg. and may be observed at the chute opening.

Procedure under this method is as follows: To rob the first row of stulls—that is, the row next to the back wall—the following row is lagged from the top down to within 3 ft. of the floor. The hook bars are pulled out with a long lever bar and from opposite side of the lagging. The stulls may now be pulled forward and from under the lagging with the rope of a slusher hoist or tackle. This operation is aided by the slight inclination of the floor. The inclination of the floor also aids slushing with a scraper into the chute, but is not great enough to render the handling of timber and other materials difficult. This is the difficulty that is one of the main objections to regular incline stopes.

With the method outlined not only may most of the stulls be saved but excessive breaking of the floor planks caused by shooting the props will also be prevented. The operations need not be less safe than by the customary shooting of the stulls. Workmen stand on the safe side of the lagging when pulling out hook bars and stulls to let down the back. A little longer time is required after mucking out to lay the sills and floor before placing the stulls with foot blocks than by the ordinary method. Vertical stulls can carry a greater load than inclined stulls before failing and can be pulled off the inclined floor more easily. Care must be taken to spot the foot blocks properly over the sills and to make the footing as solid as possible.

The proposed method will not work well in the first few slices or where the stulls are taking too much load, in which case foot blocks will crush. After the timber mat becomes a more elastic mass, most of the foot blocks will not crush with the load, and when the stulls are pulled the collapse of the back will be gradual rather than sudden.

FERNANDO MONTIJO.

Cananea, Son., Mexico.

A Professor's Personalities

To the Editor:

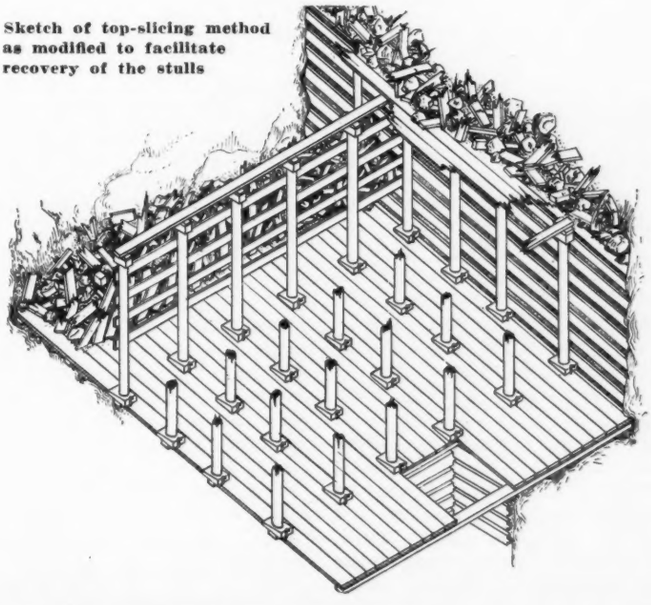
The untimely death of Alfred James reminds me that some of the most valuable articles in the *E.&M.J.* during recent months have been those by James, J. R. Finlay, and Lynwood Garrison. Such experienced engineers do the profession a favor when they express the mellowed wisdom of long observation in such pointed advice. Reading one of their articles written in a personal vein is like chatting with a respected veteran when he is in a revealing mood. It is perhaps even better than a talk, because conversation nowadays is at the mercy of telephone interruptions and trivial diversions.

Some months ago I suggested in these columns, after writing the biographies of James Douglas, Rossiter Raymond, Louis Janin, Hennen Jennings, D. W. Brunton, and Horace Winchell for the "Dictionary of American Biography," that the engineers of today are perhaps less generous and courageous than in the days when Clarence King roamed the Western hills and Hamilton Smith dogmatized in his picturesque fashion. Perhaps I was wrong. When I see James, Finlay, and Garrison sending such important information to the *E.&M.J.*; when Foster Bain leaves the Institute with such an enviable list of friendships; when T. A. Rickard, of many memories and battles, visits Edgar Rickard before publishing his history of metals; when W. J. Loring demonstrates again his adaptability in finding ore in any Western state where he happens to look; when Lake Superior veterans like S. R. Elliott and Ocha Potter attain new achievements in old districts, or men like Harry Roscoe, Enoch Henderson, and Lucien Eaton win laurels in far fields—then certainly there is much credit due the profession. Look also at J. B. Tyrrell, R. E. Hore, and Walter Segsworth in Canada.

After writing my biographical article on Rossiter Raymond, I sent it to Arthur S. Dwight and Mrs. Elizabeth Bellinger for suggestions. Mrs. Bellinger is the daughter of Raymond and was with him at many gatherings of mining engineers. She read my article on her father and other references to the striking engineers of the past with understanding and appreciation. They recalled to her the days when American young men fresh from the mining schools of Europe opened up the productive regions of our country, when romantic figures like Janin, Winchell, and Brunton strode the stage and spoke their opinions, and when engineers were truly little brothers of the rich. Those spacious days are gone forever, but perhaps our modern engineers, working more quietly, are doing as wonderful things as their predecessors; and perhaps they are as generous as James Douglas and Hamilton Smith, and as courageous as Herbert Hoover, F. Augustus Heinze, and T. A. Rickard.

P. B. MCDONALD.

New York University.



Sketch of top-slicing method as modified to facilitate recovery of the stulls

Obituary

Bruce C. Davey, vice-president of the Denver Equipment Company, died suddenly on Nov. 4, in Chicago, following a heart attack. Mr. Davey had a wide circle of friends among mining men.

Capt. George Francis, 64 years old, an employee of Quincy Mining Company for 37 years, died in Hancock, Mich., Nov. 3. He was a native of Redruth, Cornwall, England, coming to the Michigan copper district when he was twelve years of age.

John B. Treadwell, a mining engineer who went to California 59 years ago and was connected actively with the mining and oil industries of the state until his retirement from business a year ago, died in Los Angeles Nov. 5 at the age of 84. During the early days he was associated with the Flood-Mackay-Kean-O'Brien-"Lucky" Baldwin group, and was connected with the development of several of the most productive mining properties. He was in charge of the Comstock mine in Virginia City in 1874. He was formerly president and chief engineer of the International Mercury Company, recently amalgamated with the American Mercury Company.

New Publications

DEEP WELL DRILLING. *Third Edition. By W. H. Jeffery, Houston, Tex.: Gulf Publishing Company; pp. 816; illus.; $6; London: The Technical Bookshop.*

Although dealing primarily with the principles and practice of deep-well drilling, as employed in oil-field exploration and development, this book contains much that will be useful and informative, as well as suggestive, to anyone engaged in deep-hole drilling in the mining industry and elsewhere. The earlier editions have had considerable vogue as textbooks. Compared with the first edition of ten years ago, the third is practically a new book because of the changes in drilling practice and equipment in the period elapsed—changes which the author attributes in large measure to the greater part played by the engineer, as such, in oil-field work. After a preliminary discussion of petroleum geology, of geophysical prospecting, aërial mapping and kindred topics, Mr. Jeffery launches into his subject, taking up first the rotary system of drilling, which he treats in great detail and in a most practical way. His explanations are supplemented by a profusion of photographs, detailed line drawings, and charts. He next discusses the use of mud fluid and the practice of coring, including diamond drilling, thence passing to a similar detailed description of cable-tool drilling and the equipment required. This brings him to a point about midway of the book. The remaining half is devoted to such phases of the subject as the cause and correction of crooked holes, water supply, casing methods and cementing, shooting wells and completing them, pumping wells and forced recovery of oil, and, in conclusion, the cost of drilling and the lighting of rigs. Three chapters more are appended, dealing with strength of materials, standards and codes of practice, and general information.

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THE MINERAL INDUSTRY DURING 1930. *Edited by G. A. Roush. Volume XXXIX. Pp. 815. New York: McGraw-Hill Book Company, Inc.; $12. London: McGraw-Hill Book Company, Ltd.*

So far as is possible, this volume covers the developments of the year in each individual field, including production and trade statistics, technical progress, extensions of plants, new sources and uses, market conditions and prices, and other items of interest, both domestic and foreign, each subject being placed in the hands of a specialist. In the list of contributors one new name is included, that of George S. Herrick, who has taken over the iron and steel section. Frank L. Hess, after one year's absence, again has taken up the section on radium, uranium, and vanadium.

As one further step in the consolidation of related subjects, the former separate section on borax has been incorporated in the chapter on sodium salts. In addition to the regular sections found in past volumes, an interesting and valuable graphical record of metal prices over a long period of years has been included.

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MINERAL INDUSTRY OF THE BRITISH EMPIRE AND FOREIGN COUNTRIES. *Statistical Summary (Production, Imports and Exports) 1927-1929. Pp. 371. London: His Majesty's Stationery Office; 5s. 6d. net. New York: The British Library of Information, 551 Fifth Ave.; $1.45 plus postage.*

Throughout this volume, material imported and exported on government account has been used as far as possible. The statistics include data for 48 products, non-metallic minerals, non-ferrous metals, iron and steel, and rare metals; and their production, import, and export in the British Empire and the principal countries of the world.

■ ■

STANDARD METAL DIRECTORY; *1931* EDITION. *Pp. 778. New York: Atlas Publishing Company, Inc., 150 Lafayette St. Price $10.*

The sixth edition of this reference book follows the same plan adopted for previous editions. The first 480 pages contain a directory of metal-manufacturing and metal-working plants in the United States and Canada, arranged by states or provinces. In general, the principal officials, financial structure, and furnace equipment are given, together with a list of the company's principal products and the principal raw materials consumed. The remaining pages of the book are devoted to a geographical list of aluminum, brass, gray iron, malleable, and steel foundries; metal merchants, rolling mills, sheet metal and stamping works, ingot metal manufacturers, die-casting manufacturers, scrap-metal dealers, and various other classifications to which the companies listed in the front of the book lend themselves. Several tables and lists of chief interest to primary non-ferrous metal producers are reprinted from the Yearbook of the American Bureau of Metal Statistics.

■ ■

AFRICA UNVEILED. *By Owen Letcher. Waterlow & Sons, Ltd., London E.C. 2. Also published by the author, at 43 Calcutta House, Johannesburg, South Africa. Pp. 152; 7½x5 in.; price, 5s.*

FOLLOWING close upon "Cohort of the Tropics," reviewed in these pages last June, this latest offering from Mr. Letcher, who is the South Africa correspondent of *Engineering and Mining Journal* continues in both form and substance the revealing anecdotes and intimate interpretations that characterize his earlier work. Letcher loves and reverences his Africa, and he possesses the literary instinct and technical ability to convey to his readers the emotions that inspire and evolve his vivid—often livid—creations. The intellectual combination of expert engineering and geographic and geologic knowledge with a flare for the exotic and unusual makes the small volume now under review an exciting companion for a leisure hour or so.

In the still mysterious land that claims the author for its own, death is as truly the potion of each day as is life itself Africa is still primitive—still fresh from the matrix of the Creator. Letcher presents her thus, and is able to convince his readers that he has added little to, and taken nothing from, the drama of nature of which the continent is, even now, so fascinating an example. Three chapters are notably distinctive: "A Peep Into Genesis," "The Place Where the Elephants Die," which continues and pictures luridly the tradition respecting the great beasts' self-appointed sepulcher, and "The Wells of Kobis," wherein a far-flung and isolated outpost of the world, half German, half British, its respective staffs friends and comrades all, is in an instant, by imperial command, turned into a pit of hell terrible and revolting beyond imagination, but revealed in lightning flashes of word painting that convey, by implication, more horrors, even, than these pages picture forth.

Mr. Letcher takes a chance—a long one, the world will hope—at prophecy. In his final chapter, "1940," he describes the preludes to and the military engagements in an air war between the Mediterranean Powers and the defenders of Africa. As a study of probabilities in the years just ahead, the chapter, and the author's final word (or is it warning?), are worth study and pondering.

The work leaves the serious reader wide awake and a little troubled. Patently, that may well be Mr. Letcher's objective.

W. N. P. REED.

INDUSTRIAL PROGRESS

Cost of Maintaining Largest Sintering Machine Notably Low, as Estimated

Mine and quarry operators who have a product that is being sintered, or can be so treated to advantage, will be interested in the following facts regarding the cost of maintaining the Dwight-Lloyd machine used by the Evergreen Mining Company, of Crosby, Minn., in improving the grade and structure of Cuyuna Range iron ores. The attention of quarry operators, as well as of producers of sulphide ores and iron ores, is drawn to this matter, because sintering is being applied today in preparing limestone, dolomite and other nonmetallic products for market, the latter even including certain grades of crushed stone produced for special purposes. This sintering machine at the Evergreen, as described in *E.&M.J.* of Sept. 28, 1931, on page 244, is the largest of its kind in the world, being 72 in. wide and 125 ft. long, and it is operated with a bed 18 in. deep.

For repairing breakages or otherwise damaged parts on the machine and the accessory equipment, the following crew is maintained: one electric arc welder, one acetylene welder and blacksmith; two semi-skilled mechanics and a master mechanic. Ordinary semi-skilled mechanics can take care of practically all repairs with the aid of a welder thoroughly familiar with the hard surfacing of wearing parts, such as pugmill paddles. Minor repair work required can be done by the machine operators. Repair charges per ton of sinter incurred in treating 374,048 tons of sinter (corrected to allow for costs out of normal, such as those incurred in rebuilding for experimental purposes), are given in the accompanying table, through the courtesy of Perry G. Harrison, general manager of the Evergreen. In addition to these charges, other maintenance charges will have to be made later for renewal of wind boxes, sealing bar slide, track, and the like—expenses which have not yet been incurred and some of which cannot be expected until several million tons have been handled. In the aggregate, according to Mr. Harrison, they cannot amount to more than 2c. per ton.

As for repairs or replacements due to abrasion or wear, pugmill paddles have to be replaced more often than any other equipment for this reason, according to D. C. Pettyjohn, Mr. Harrison's assistant. By using a hard surfacing material on the blades, an average life of 37 days is obtained, equivalent to approximately 100,000 tons of ore, coke and return sinter. The change is made in two hours. A new set of paddles for the pugmill would cost about $115. This expense is avoided by welding electrically a piece of ½-in. boiler plate to the remaining paddle, thus getting a new set for $25. The cost of hard surfacing a set of paddles is $65.

Sinter Plant Maintenance Costs 1930 and 1931 to Date
374,048 Tons of Sinter

	Per Ton Sinter
Sinter grates	$0.0281
Pugmill	0.0037
Pallets and wheels	0.0157
Dust collectors	0.0030
Sinter fans	0.0053
Electrical, motors	0.0043
Sinter furnaces (ignition)	0.0060
Feeders	0.0019
Shafting and belts	0.0004
Collector conveyor	0.0003
Classifier	0.0006
Sinter machine proper	0.0031
Sinter discharge chute	0.0018
Loading and cooling equipment	0.0015
Oil tanks, pumps	0.0002
Chutes and hoppers	0.0012
Total	$0.0771
Division to labor and supplies:	
Labor	$0.0136
Supplies	0.0635

The plant has two fans, one on the intake end of the sintering machine which furnishes the vacuum for the first eight windboxes, 45,000 cu.ft. per minute capacity. On these fans the blades were replaced twice in 1930, after the treatment of 275,000 tons of sinter: the other fan, on the discharge end and of 60,000 cu.ft. per minute capacity, furnishes the vacuum for the last twelve windboxes and ran throughout the 1930 and 1931 seasons without replacement of the blades, during which period 301,732 tons of sinter was produced. However, this fan is expected to require some work on the blades this winter. The fan housings are repaired by electric welding while the plant is in operation. About 8 hours is required for replacing the blades. The latter are also hard-surfaced before being installed.

The wear on chutes and hoppers is considerable, but they are repaired by welding, usually, while the plant is in operation, although sometimes temporary repairs only are possible, in which case the work is delayed until the time is convenient for shutting down, when the repairs are done all at once. In 1930, shutdown for this reason amounted to about 8 hours each month. The plant ran 95 per cent of possible operating time.

As for repairs due to heat, the grate bars have to be replaced more often than any other equipment for this reason. The life of a bar is about 100 days; the cost, 0.0326c. per ton of sinter. Bars are changed without shutting down.

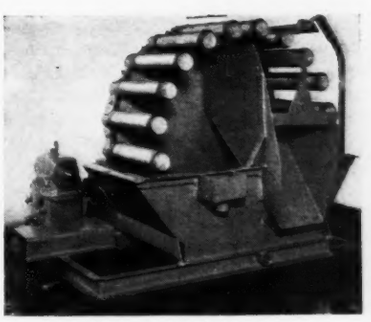
■ ■

A New Type of Continuous Vacuum Filter

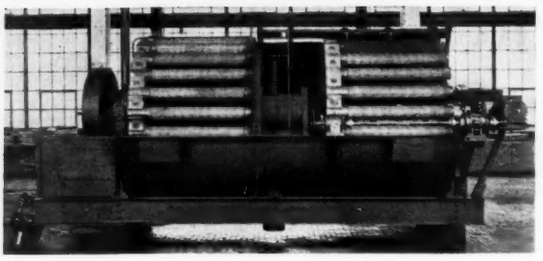
Other Recent Equipment Includes a Novel Apron Bin Gate

A NEW FILTER embodying a novel principle in continuous vacuum filtration and applicable in the treatment of a wide range of products has recently been introduced by the Bartlett Hayward Company, Baltimore, Md. It is known as the B. H. Co. (Genter type) oscillating continuous filter.

Preliminary tests with the filter have been started in dewatering cement slurry, and excellent results are said to have been obtained. On iron-ore dust



Single unit, new continuous vacuum filter



Twin unit of the B.H. Co. continuous vacuum filter

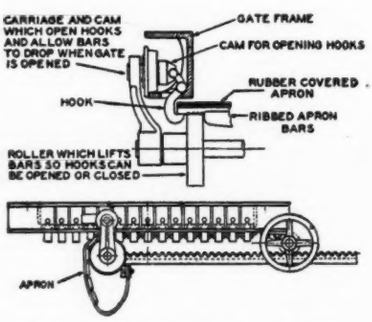
caught in blast furnace scrubbers and followed by thickening, the filter developed capacities varying from 1,000 to 1,200 lb. of dry substance per square foot per day, with a cake moisture of about 17 per cent. In dewatering coal-washing sludge, the capacity was found to vary from 1,500 to 3,000 lb. of dry solids per square foot per day on sludges containing 40 to 50 per cent solids and having various percentages of plus and minus 48-mesh material. The moisture varies from 21 to 30 per cent according to the amount of minus-200-mesh material and fine clay present. The filter has also been used in dewatering chemically treated, digested sewage sludge with a capacity of 72 to 192 lb. of dry substance per square foot per day, according to the chemical treatment given, the moisture varying from 68 to 70 per cent. These citations indicate the wide range of possible applications. Owing to its structural and mechanical features, the designers think that the filter will prove in general superior for dewatering mineral flotation products and all hydrometallurgical products. Claims are made by the manufacturer that for final washing of cyanide pulp the new filter has a distinct advantage. The double unit shown in one of the illustrations was built for filtering and washing colloidal sulphur from a liquid purification process, this indicating its possible application for filtering, washing, re-pulping, rewashing, and drying cyanide slimes.

Two of the illustrations show the filter in a double and single unit respectively. Essentially, the filter consists of individual tubular elements arranged in squirrel-cage fashion about a central shaft, as shown. The cage is open at one end, the filter elements being built on the cantilever principle. These elements also serve as oscillating agitating arms as they work their way to the tank through which they revolve. By a gear-driven mechanism on one end of the central shaft the shaft and elements are caused to oscillate in a continuously progressive manner around a complete circle. This movement can be suited to the material filtered. The tubular elements are clamped firmly at one end to a spider which contains the filtrate conduits leading to a rotary valve mounted on one end of the central shaft. This valve automatically controls the application and cessation of suction on the elements on submerging and leaving the drying arc, and then permits the application of atmospheric or low-pressure air for discharging the cake. The driving gear is attached either to the valve end or to the opposite end of the central supporting shaft.

Use of the cantilever filtering element makes possible three types of design—namely, a single unit, a twin unit, and a double unit. The single unit consists of one series of tubes coupled to the spider located at one end of the central shaft. This construction is considered preferable for small units and installations where the head room is ample and the longitudinal space is restricted. The twin unit (not shown) has two series of tubes, one end of each series being clamped to a common spider at the center of the horizontal supporting shaft. This construction permits the installation of a large area upon one shaft. The double unit consists of two single-end filters on one shaft in one tank having a dividing wall so that two products can be simultaneously filtered, or the contents of the first tank filtered, washed, and repulped in the first unit, and refiltered, rewashed, dried, and discharged in the second unit. A conveyor and trough supported eccentrically lengthwise within the filter cage receives the dried or washed cake and conveys it through the open end of the filter for discharge.

When the cake-coated tubes have progressed in their oscillatory manner to a position directly above the cake conveyor, the suction is cut off automatically and successive tubes oscillate past a port admitting either atmospheric or low-pressure air. This loosens the cake on the filter medium and discharges all or part of it into the conveyor. The remainder, if any, is removed immediately afterward as each successive tube oscillates under one or between two wipers which do not touch the medium.

The tubular elements are so constructed that they permit the removal of the entire filtrate from beneath the enveloping filter medium. The latter is a simple cylindrical envelope of any desired material slipped over the tube and fastened at both ends.


CARRIAGE AND CAM WHICH OPEN HOOKS AND ALLOW BARS TO DROP WHEN GATE IS OPENED
GATE FRAME
CAM FOR OPENING HOOKS
RUBBER COVERED APRON
HOOK
RIBBED APRON BARS
ROLLER WHICH LIFTS BARS SO HOOKS CAN BE OPENED OR CLOSED
APRON

Sketch of new apron gate, showing how apron bars are held in place, and how they are released when gate is opened

A Novel Apron Gate

An entirely new principle has been used in designing a new apron gate introduced by Stephens-Adamson Manufacturing Co., Aurora, Ill. This is intended for horizontal bin bottoms. Sliding friction has been eliminated, and the largest size of this type of gate can be opened by one man readily, in contrast to large gates of the usual slide or swinging quadrant type, which are notoriously hard to open. The opening of the new gate is closed by a series of reinforced cross bars covered with a wear-resisting rubber apron which prevents spillage and the leakage of drain water between the bars. In opening, the bars are lifted one by one, unhooked, and lowered from beneath the material above the gate opening, which accounts for the ease of operation. To open and close the gate an operating carriage is moved back and forth by means of a rack-and-pinion driven by hand or chain wheels. In opening, the carriage is pulled backward, causing the two lower rollers to lift the apron bars slightly, and disengage the hooks. The cams shown in the cut hold the hooks out until the rollers have passed and the apron has dropped. In closing, the carriage is pushed forward, the cams open the hooks, the rollers lift the bars into place, the hooks engage, and the apron bars support the load in the bin above. The new gate is of durable light-weight construction and requires little headroom. It is said to be suitable for large openings.

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Bulletins

Pumps—Worthington Pump and Machinery Co., Harrison, N. J. Specification Sheet No. D-412-S6. Power pumps, horizontal-duplex-piston pattern.

Gas Burners—Denver Fire Clay Co., Denver, Colo. Bulletin No. 306, DFC atmospheric gas boiler burners (type C).

Furnaces—General Electric Co., Schenectady, N. Y. Bulletin GEA-1146A, electric furnaces.

Crushers—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 1827-B, Superior jaw crushers.

Filtration—Bartlett Hayward Co., Baltimore, Md. Booklet, oscillating continuous filter, "Genter type."

Welding—Torchweld Equipment Co., 224 N. Carpenter St., Chicago, Ill. Catalog No. 31, welding and cutting equipment.

NEWS OF THE INDUSTRY

Power Supply Limits Scale of Preliminary Operations at Yellow Pine, Idaho

By the end of 1931, a 150-ton pilot mill to treat gold-antimony ore will be in operation at the Yellow Pine property, Valley County, Idaho, according to F. W. Bradley, who controls the company. Eventually, the scale of operations will probably be much greater, perhaps 2,500 tons of ore daily, but for the present it is limited by lack of available power. Because of the remote situation of the property (it is 80 miles over mountainous country from the nearest railroad), hydro-electric power must be depended on for regular operations. Although ample water flow is available in the spring and summer, it cannot be depended on during the remainder of the year. Mr. Bradley, when interviewed by an *E.&M.J.* representative, also discussed the situation at the numerous other properties in which he has an interest.

The Yellow Pine property carries several gold-antimony orebodies in the Meadow Creek vein as well as some quicksilver deposits in what is known as the Cinnabar section. The pilot mill now nearing completion (all buildings have been erected and all equipment is on the ground) will handle material that runs $8 to $9 a ton in gold and 2 to 3 per cent antimony. After crushing in a Symons cone, and grinding in a Hardinge ball mill in closed circuit with a Dorr classifier, the antimony content will be recovered in Kraut flotation equipment. Another Kraut machine will make an iron concentrate, containing gold and silver, which will be roasted in a Nichols-Herreshoff roaster before cyaniding. Antimony concentrate will be stored during the winter and shipped in the spring to a Salt Lake Valley smelter. For this work, 1,100 hp. is available in the present plant.

If results from this pilot work are successful, the company plans to develop additional power, probably as much as 8,000 hp. This will then permit enlarging the scale of operations and handling lower-grade material. A large tonnage running $5 a ton in gold is available. In addition to enlarging the concentrator, a unit will be built to recover antimony metal electrolytically, thus saving the heavy cost of shipping concentrate. At present transportation in summer is effected over an old mountain road. In winter, an airplane is used almost exclusively.

Development of the Meadow Creek vein has been undertaken through the Meadow Creek tunnel, at an elevation of 6,700 ft. A new tunnel, the Monday, is being driven about 400 ft. lower. At a distance of 9,000 ft. from its portal it will connect with a shaft from the Meadow Creek tunnel. The quicksilver deposits are to be developed through a new tunnel, known as the Cinnabar, which will reach a maximum depth of 2,000 ft. below surface. This tunnel is not being hurried at present, because of the condition of the quicksilver market.

Production from the quicksilver properties in California and Nevada in which Mr. Bradley is interested is now about 700 flasks a month. This is probably greater than the output of any other United States producer.

With respect to Alaska Juneau, the low-grade gold producer at Juneau, Alaska, which Mr. Bradley has made into a profitable mine, he stated that sinking of the second winze to explore the North orebody at depth has been started. The first winze, put down 800 ft. on the dip of the formation (600 ft. vertically), showed high-grade quartz veins, alternating with stretches of slate in which only a few cents of gold per ton occurs. If the second winze proves up as well, production from this orebody on a substantial scale will start next year. The entire deposit will be mined, low-grade slate being sorted out after crushing. The North orebody material will be treated in the present mill and is expected to improve average grade substantially. At present the yield from the South orebody is about 90c. a ton.

Mount Juneau, which controls groups adjoining the Ebner property at Juneau and which is being developed jointly by Alaska Juneau and Treadwell Yukon, both Bradley companies, is being opened up through a tunnel, that has already been driven about 1,000 ft. along the strike of the formation. It has about 6,000 ft. to go before encountering the boundary line. The success of the enterprise will depend on the number of gold-bearing quartz stringers found over stoping width.

Production is being maintained by Bunker Hill & Sullivan, Bradley enterprise at Kellogg, Idaho, despite present low prices of lead and silver. Development of the new Flood-Pike-Stanly oreshoot, discovered about two years ago, indicates that it merges with the main Bunker Hill orebody at depth, but a considerable tonnage has been added to reserves by the work.

The Sullivan Mining electrolytic zinc plant, near Kellogg, in which Bunker Hill has a 50 per cent interest, has recently reduced its output to 15 tons of zinc daily because of weakness in the zinc market. The plant had been producing about 30 tons daily, capacity being 60 tons. It is being supplied with concentrate from the Bunker Hill and Hecla mines, as well as with custom material from mines along Pine Creek (notably the Sidney). At the Star mine, owned by Sullivan Mining, which is normally the largest source of supply for the zinc plant, but which has not produced for more than a year, development of the new ore found in the hanging-wall country on the upper levels continues favorably. The lead content of this ore is proportionally greater than that of the main Star orebody, and, if it develops well in depth, the Star may possibly be reopened on the basis of a lead rather than a zinc operation.

Leadhill Mines, the Bunker Hill subsidiary which controls a large area in the Metaline Falls lead-zinc district of Washington, is developing low-grade deposits that may eventually form the basis of a large-scale operation. The work is still in the prospect stage, however. This also applies to the Treadwell Yukon development in Louvicourt Township, Que., where preparations are being made to sink a shaft. Drilling has indicated the presence of free gold, but lateral development will be necessary to prove grade and tonnage.

Of the other Treadwell Yukon properties, Bodie, in California, is continuing with its surface exploration work in spite of the cessation of underground activities. Pumping costs of $5,000 monthly were too high to warrant further development underground. The one high-grade streak on the 700 level yielded about $100 in gold per ton from a length of 135 ft. and a width of 2 ft. when milled. The Wernecke operations, in Yukon, shipped more than 4,000,000 oz. of silver this year. At Errington, the drift on the 1,500 level is now entering the zinc-copper-lead deposit indicated by drilling. It is more than 6,000 ft. from No. 3 shaft.

■

Aldermac Mill Nearly Ready

Aldermac Mines, subsidiary of Noranda Mines and Towagmac Exploration, will complete its new pyrite concentrator near Rouyn, Que., in December. The new plant can handle 500 tons of ore daily, from which a production of about 300 tons or iron concentrate, containing about 50 per cent sulphur, is expected. The concentrates will be marketed in Canada through the Sulphide Research Corporation. The sulphur content will be used in newsprint production. The residue of this process, an iron oxide, containing about 65 per cent iron, will be used in the Canadian iron and steel industry.

A large tonnage of material averaging about 2 per cent copper and about 75 per cent iron pyrites has been developed at the mine. No official estimate of reserves has been published. Metallurgical tests have shown that about 90 per cent of the copper in the ore can be recovered in a high-grade copper concentrate, which will be shipped to the Noranda smelter.

C.F.&I. Discovers Body of High-Grade Ore at Sunrise

Discovery of a large body of high-grade ore near the present Sunrise mine, at Sunrise, Wyo., has been announced by officials of Colorado Fuel & Iron. The discovery came after more than two years' work by company engineers and geologists, officials said. The new orebody is between the present mine and the abandoned Chicago mine.

Development of the new deposits will be undertaken as soon as business conditions warrant, officials said. The ore was discovered by drill crews which have been exploring the territory with diamond drills since last May. Work is being continued to find the limits and tonnage of the orebody.

"The discovery is of tremendous importance to the Colorado Fuel & Iron Company and to Colorado and Wyoming in general," W. A. Maxwell, vice-president of the company at Denver, said. "The company has been buying large quantities of iron ore in New Mexico for more than seven years. With the newly discovered deposits this no longer will be necessary."

Surveys of the districts were started in October, 1929. Electric and magnetometer geophysical survey instruments were used in an attempt to outline the general stucture underneath the carboniferous capping which covers the region. In April, 1930, surface geological surveys were started by Dr. John B. Stone, C. F. & I. geologist. His work resulted in the decisions to start exploratory work with diamond drills.

Actual drilling began in May of this year. The first ore was struck June 16. Since that time drilling has continued to outline the shape of the orebody and determine the grade of ore and tonnages present.

■

Extend Line to Sulphur Mine

Construction of a 3-mile extension in Vermilion Parish, La., to reach the site of a sulphur-mining plant to be erected by the Jefferson Lake Oil Company on the bank of Lake Peigneur has been proposed by the Texas & New Orleans Railroad and the Iberia & Vermilion Railroad in an application filed with the Interstate Commerce Commission. The line would extend from Clesne, a station on the Erath Sugar Company's line, which connects with the Midland Branch of the Iberia at Erath. Purchase of the sugar company's line by the carriers has been authorized by the Commission. Construction of the extension will be financed out of current surplus.

■

New Florida Phosphate Plant

Dunnellon Phosphate Mining recently shut down its phosphate plant at Pleasant Grove and moved all equipment to its Hernando property, near Inverness, Fla. Construction of a new plant, offices, and dwellings for employees will be started soon. Stripping of overburden and building of a track from the mine to the plant will also precede actual mining operations. No definite information has yet been issued as to the date when regular mine production will start.

■

C. & H. Stops Work at Phoenix

Calumet & Hecla Consolidated has temporarily suspended exploratory operations in its Phoenix property in Keweenaw County, Mich. Cliff was shut down early last February to conserve the limited funds of the Cliff company. Work was then centered in Phoenix, as any horizon found to have commercial possibilities could have been explored in the Cliff property, which adjoins. Pumping will continue in Phoenix as it has been in Cliff, keeping both shafts in condition for resumption of work when copper metal conditions warrant. Phoenix was engaged in sinking when operations ceased. The shaft already had been sunk 1,000 ft. below the No. 16 level, and was to be lowered another 500 ft. It is now about 150 ft. from its objective, from which point search will be continued for a major or mother lode. Mineralization was not in evidence at the bottom levels on the old fissure veins; hence the decision to go deeper.

■

Pend Oreille Buys Concentrator

Pend Oreille Mines & Metals, which has been producing zinc and lead concentrates from its 200-ton mill near Metaline Falls, Wash., has concluded an agreement with Grandview Mines, whereby the latter company's plant, in the same district, will be purchased for $100,000. This amount is payable at the rate of $1 per ton of concentrate produced. In addition, the agreement provides for treatment of Grandview ores. The Grandview mill has a rated capacity of 250 tons, but a considerably larger crushing capacity. The Pend Oreille management hopes that, by transferring the flotation equipment from its old mill, capacity can be raised to 750 tons daily. In addition, a wire-rope tramway will be built to connect the Josephine mine of Pend Oreille with the Grandview mill.

The Hidden Falls tunnel of Pend Oreille has recently cut the Josephine orebody 500 ft. below the surface and 200 ft. below the previous deepest level. Ore is said to be of better grade than the mine average.

■

Shattuck Denn Concretes Shaft

Concreting of the Denn shaft at the Shattuck Denn properties, in the Bisbee district, of Arizona, is now under way. The company will concrete the entire shaft to its present bottom, at 2,200 ft. When this work is completed, which should be some time in the summer of 1932, the shaft will probably be deepened to 2,600 ft. to permit development of the new copper orebody indicated by recent diamond drilling below the 2,200 level. Decision on shaft sinking will probably depend on the condition of the copper market. If substantial improvement is not indicated by the time the concreting is completed, the company may decide to conserve its cash resources temporarily. At present, no other work is being done save the concreting, as diamond drilling has been completed and actual ore production has been suspended since the fall of 1930.

■

Teck Report Shows Drop in Grade With Greater Depth

Development on the Nos. 26, 27, and 28 levels of the Teck-Hughes Gold property, at Kirkland Lake, Ont., shows that the ore is under the average both in tonnage and grade, according to D. L. H. Forbes, general manager. As a result, reserves at the end of the company's fiscal year (only ore broken or blocked out is included) were 645,384 tons, averaging $14.28 a ton in gold, compared with 576,289 tons, averaging $17.43 a ton, at the end of the previous year. Work is now being done on the Nos. 29, 30, and 31 levels, the deepest in the mine.

The mine management plans to sink to the No. 55 level, which will be at a depth of 6,730 ft. One winze is already being put down from near the central shaft, at the No. 30 level, and preparations are being made for deepening the south shaft. Main haulage levels will be at intervals of 625 ft., with intermediate levels every 125 ft. The No. 31 level is 3,730 ft. below surface.

In the fiscal year ended Aug. 31, additions to mill capacity were completed and a total of 396,200 tons of ore was treated, which yielded $15.08 a ton. Operating cost, per ton treated, was reduced from $6.41 in the previous year to $6.06 and the cost per ounce of gold was $8.305, including depreciation. Development work totaled 19,984 ft., of which 11,220 ft. was drifting.

■

High-Grade Strike at Union

Crosscutting on the No. 1 tunnel level of the Union gold-silver mine, near Lynch Creek, B. C., recently cut a high-grade gold oreshoot. Hecla Mining, which operates the property, has made a shipment of 56 tons of ore to the Bunker Hill smelter, at Kellogg, Idaho. The oreshoot, where struck, was about 250 ft. below the surface. The Union mine has been producing about a carload of concentrate weekly from its 150-ton mill. This concentrate has been shipped to the Consolidated M. & S. plant at Trail, B. C., for smelting. In its most recent annual report, the Hecla management stated that the Union orebody "is small and will be exhausted during 1931 unless other deposits are disclosed not now known. . . . We are making an operating profit from this property, but from present indications the venture will result in a loss."

■

Open North Carolina Feldspar Mine

Development of a new feldspar mine near Bear Creek, in Mitchell County, N. C., has been started. A monthly production of 500 tons of feldspar is expected from this property.

Propose Merger of St. Mary's With Copper Range Holdings

Directors of both St. Mary's Mineral Land and Copper Range have reached the conclusion that it would be advantageous for their respective stockholders to have Copper Range acquire all the property and assets of St. Mary's, on the basis of one share of Copper Range stock for each share of St. Mary's outstanding. The result would be to combine the properties and businesses of the two companies. The proposal is contingent on the favorable action of the stockholders of both companies. A special meeting of St. Mary's stockholders will be held Nov. 24 at Jersey City, N. J., and a special meeting of Copper Range stockholders Dec. 14 at Boston.

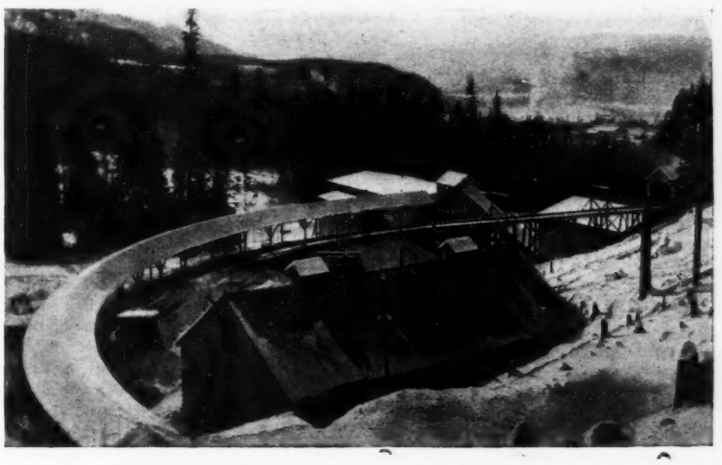
The proposal is to increase the capital stock of Copper Range by not more than 160,000 additional shares, all stock to be without par value. Copper Range capitalization at present is 400,000 shares, par value $25, of which 395,000 shares are outstanding. The articles of association will be amended so as to make the shares without par value. The proposed merger is expected to result in more effective and economical management of the properties of both companies. Duplications can be eliminated and substantial tax savings made. If the proposal is consummated, the Copper Range board of directors will be increased from seven to twelve, and five of the present St. Mary's directors will probably be members of the Copper Range board.

The share for share basis has been worked out on a comparison of the relative value of the assets. Copper Range has important properties in the Michigan copper district in addition to its interest in Champion and its lands. It has a large interest in Copper District Power, from which it expects a substantial return. It has recently acquired a large interest in C. G. Hussey & Company of Pittsburgh, a large consumer of Champion copper. It owns the Baltic property. It owns all the stock and nearly one-half the outstanding bonds of the Copper Range Railroad. So far this year the railroad has not fully earned bond interest, but any substantial improvement of present conditions should be reflected in its earnings.

Consolidation would give Copper Range ownership of about 100,000 additional acres of mineral lands in Michigan, largely adjoining its own holdings; it would bring full ownership of the Champion property, in which Copper Range and St. Mary's now have an equal interest; and ownership of Pacific lands. The Champion mine in normal times is a profitable producer, and half of its profits go to St. Mary's stockholders. Under present conditions, however, Champion is operating on a reduced scale and is showing an operating deficit before property taxes, depreciation, or depletion deductions. Pacific, along with Atlantic, owned by Copper Range, probably will be opened for development of the Ashbed lode series when the metal market strengthens. Combined Atlantic and Pacific acreage makes for an extensive area on the strike of the formation.

Copper Range's policy of expansion during the last two years has given it a wide territory with mineral possibilities which appear to assure this company a long lease of life. It has acquired during that time the White Pine, Victoria, and National mine properties in Ontonagon County, mineral rights adjacent to the Atlantic in Houghton County, and the acreage of the Naumkeg company, also carrying the Ashbed and Pewabic beds. A diamond-drilling program carried on during the last two years has revealed good values in the Isle Royale lode, and in the southerly extension of the Baltic lode, in Globe lands. To aid it in its present and future operations, Copper Range's interest in the Copper District Power Company, with developed water power on the Ontonagon River in Ontonagon County, assures cheap power for all purposes.

■ ■ ■



Surface plant of Grandview Mines, in the Metaline Falls zinc-lead district. The mill that has been leased to Pend Oreille Mines & Metals may be seen in the right center (see p. 470 for details).

■ ■ ■

Tonopah Extension Reopens

Tonopah Extension, which, in 1930, was the largest silver producer in Nevada, resumed operations at its property at Tonopah, Nev., on Nov. 9. The recent increase in the price of silver was the cause for reopening. The property closed down at the end of 1930, when silver dropped to 30c. an ounce, despite the fact that development work had opened new ore reserves. High pumping costs were the chief factor in making operations unprofitable.

At the time of suspension, about 140 men were employed in the mine and mill. Production in 1930 was 1,507,375 oz. of silver and 14,770 oz. of gold from 98,486 tons of ore. Thomas F. Cole is now managing director of the company, succeeding John G. Kirchen, who died recently.

None of the other Tonopah companies are now operating, although leasers have been active, keeping the Tonopah Mining plant at Millers supplied with a small tonnage of high-grade ore.

■

Test Gas for Manganese Plant

Domestic Manganese & Development, at Butte, Mont., will soon carry on some tests using gas instead of coal to roast pink manganese. The new natural fuel will be used on an order being prepared for the Ohio Ferro-Alloys Company. Ore will be furnished by Butte Copper & Zinc, Anaconda subsidiary.

Tailing Plant for White Caps

Mark Bradshaw, president of Bradshaw, Inc., which has been successfully re-treating the tailing dump of Goldfield Consolidated, at Goldfield, Nev., since 1927, has organized a new company, known as Tailings, Inc., to re-treat the White Caps dump in the Manhattan district. The new arrangement includes the 100-ton mill of White Caps Gold Mining, which is now being remodeled at a cost of $20,000. About 80,000 to 100,000 tons of tailing is said to be available. Operation of the mill was unsuccessful because of low recovery. Presence of stibnite is said to have been one of the chief difficulties.

■

Build Road to Nogal Canyon Mine

Construction of a road to a new gold deposit in Nogal Canyon, San Mateo Mountains, Socorro County, N. M., is to be started immediately by a group of Chicago and Denver interests. The deposit was discovered in July by Theodore K. Hellyer and claims were staked on it by Hellyer and his backer, R. P. Pankey. They have sold the claims for a reported consideration of $125,000. Most of the adjoining ground has been staked, 200 claims in all having been recorded. It is not yet known whether the ore will be treated at the mine or shipped to the El Paso smelter, by way of Hot Springs, about 45 miles southeast of the property.

BRIEF NOTES

Ashanti Development. The features of development work in October at the Ashanti Goldfields property, Gold Coast, Africa, were the revealing of a huge width of 84 ft. of reef on the No. 26 level, with an average assay of only 3.7 dwt. in gold per ton, and the development of 9 ft. averaging 24.2 dwt. in No. 12 SW crosscut on the No. 18 level. Results obtained on No. 25 level further confirm the erratic distribution of gold in the deposit, one crosscut showing 7 ft. of 7.1 dwt. and another 2 ft. of 1.7 dwt. Production was 14,776 oz. of gold from 12,787 tons of ore.

A. S. & R. in Big Bug Area. American Smelting & Refining has optioned the McCabe-Gladstone mine, in the Big Bug district, Bradshaw Mountains, near Prescott, Ariz. The smelting company is making examinations at present. The property has been developed to a depth of 1,100 ft. and has produced ore with a gross value of more than $3,000,000 in gold, copper, and silver.

Argonaut Depth Development. Argonaut Mining, near Jackson, Calif., plans to extend a winze to the 6,200 level of its gold mine. Drifts are now being driven on the 5,800 level along the oreshoot recently discovered. This oreshoot is supplying a considerable part of the 220 tons of ore daily going to the mill. Plans for an auxiliary underground shaft and hoist to serve the new area have been made.

Basin Montana to Resume. Within two weeks work will be resumed at the Grey Eagle property of Basin Montana Tunnel, near Basin, Mont., according to William H. Hax, president. The shaft will be sunk 400 ft. deeper. Financing has been taken over by Gurnett & Company, members of the New York Stock Exchange.

Boss Tweed Buys Mill. Ardsley Butte Milling, a company separate from the Ardsley Butte Mines Corporation, has sold its 150-ton milling plant, in Butte, Mont., to Boss Tweed & Clipper, of Pony, Mont. The mill is now being shipped and erected at Pony. The Boss Tweed & Clipper is expected to start gold production before the end of the year. R. H. Sawyer is manager.

Bumsted Starts Producing. During October, the new Herreshoff furnace at the Great Western mine of Bumsted Mining, near Middletown, Calif., produced 64 flasks of quicksilver from 330 tons of ore treated. This was the first production at the property since 1909. According to E. J. Bumsted, the furnace is the only Herreshoff being used for the recovery of quicksilver in California.

California Alder Opens Quartz Area. California Alder Gulch is reopening its Bell-Grant group of quartz claims, one mile south of Virginia City, Mont., and expects to ship high-grade gold ore during the winter. The combination dragline and shovel is taking off surface gravel from the alluvial deposits below Virginia City.

Chloride Cliff Plans. The Chloride Cliff and John Cyty Gold properties at the edge of Death Valley, 20 miles from Beatty, Nev., have been acquired by Chloride Cliff Mining & Milling. Some direct-smelting ore has been shipped from these claims, but the plans of the new operators are for large-scale operation involving construction of a mill. A 20-mile pipe line will have to be built to the property. Development will be undertaken through a long working tunnel and an interior shaft.

Chosen Has New Orebody. At the Great Nurupi mine, of Chosen Corporation, near Taiyudong, Chosen (Korea), development on the No. 14 level, east of the fault, has cut a large orebody. Average grade is 5.5 dwt. in gold per ton over a width of 15 ft. This is lower in grade but of much greater width than prevails in other sections of the mine. A. A. Friedman describes the Great Nurupi operations on pp. 453 and 454 of this issue.

Cons. M. & S. in Swayze Area. Consolidated Mining & Smelting has optioned twelve claims adjoining the Kenty gold discovery in Swayze Township, Ont. Option price is stated to be $200,000, to be paid over a period of two years. A crew of twelve men will undertake surface trenching on the western extension of the strike of the Kenty veins. Cyril Knight Prospecting has a crew at work on the projected extension of the Kenty veins to the east.

Double Eagle Producing. The Golden Eagle group of claims, in Crook Canyon, near Prescott, Ariz., was acquired by Double Eagle Mining in September. Since then a ten-stamp mill has been rehabilitated and enlarged. The company is now handling gold ore with twenty stamps, working three shifts. O. O. Smith is manager of the property.

Eva Creek and Alaska College. On p. 275 of the Sept. 28 issue, *E.&M.J.* stated that the Eva Creek property, in central Alaska, is under operation by the Alaska College and School of Mines to provide practical instruction for students. Ernest N. Patty, dean of the college, points out that the report is incorrect. Dean Patty is personally interested in the property, but the college is in no way connected with it.

Hanna to Continue Drilling. Announcement has been made that the M. A. Hanna Company will continue prospecting operations at the Lesinsky group of claims, carrying low-grade copper deposits, near Metcalf, in the Morenci district, Arizona. The company has been diamond drilling the property for the last year. Results are reported to have been encouraging. A. E. Walker is in charge of the work.

Kennedy Flotation Unit. Installation of flotation equipment in the gold mill of Kennedy Mining, near Jackson, Calif., has reached its final stages. Part of the concentrator floor has been cleared and a thickener is being put into position. It will receive the pulp discharge from the plants and will remove part of the water before the pulp passes to the ball-mill circuit. It will also dewater feed from the classifier to the flotation machines.

Kirkland Townsite to Resume. Sinking of the shaft of Kirkland Townsite, adjoining Wright-Hargreaves to the south, at Kirkland Lake, Ont., will be resumed as soon as rehabilitation of surface plant is completed and new equipment installed. The shaft, a two-compartment unit, is 700 ft. deep at present and will be put down to 2,500 ft. At that point, a crosscut will be driven north toward the ore zone in which Wright-Hargreaves has recently opened 200 ft. of ore averaging $12 in gold per ton. Harry Oakes, of Lake shore, is a director of Kirkland Townsite and Harold Fancy is mine superintendent.

Nevada Operations Unchanged. Operations of Nevada Consolidated continue at a virtually unchanged rate of production at its properties in Nevada, Arizona, and New Mexico. In the third quarter of 1931, the average daily tonnage of company ores milled at all three concentrators was 16,796, compared with 17,115 tons in the preceding quarter. The grade of ore handled was slightly higher, 1.26 per cent copper, compared with 1.23 per cent, but the recovery was only 21.68 lb. of copper per ton, compared with 21.67 lb. in the second quarter. Custom ore received during the quarter was only 134,267 tons, compared with 208,319 tons in the second quarter, indicating a large drop in Consolidated Coppermines output.

Princeton Gold Formed. Princeton Gold Mining has been formed by H. J. Johnson and L. A. Grant, of Helena, and O. C. Kirkwold, of Butte. The company will operate the Crevasse Mountain property near Jardine, Mont., the ore carrying gold and arsenic. J. Edgar Wild is manager.

Roan October Output. Roan Antelope, new Rhodesian copper producer, reports shipment of 506 tons of blister copper in October, the first shipment of blister it has made. In addition, 5,158 tons of 56.51 per cent copper concentrate was shipped. As additional concentrate produced during the month was in process at the smelter, recovery of copper in concentrate is estimated at about 12,000,000 lb. The mill treated 204,000 tons of ore, indicating a capacity of at least 2,500,000 tons annually, compared with rated capacity of 1,800,000 tons.

Sunnyside May Resume. Driving of the new tunnel at the Sunnyside Mining zinc-lead property, near Silverton, Colo., will be resumed if enough workers signify their willingness to undertake the work on a reduced wage scale, according to information obtained at the office of U. S. Smelting, Refining & Mining, which owns the property. The work was suspended about a month ago because the workers refused to accept a 10 per cent cut. Several applications to work at the lower scale have been received. The tunnel is the only project at Sunnyside on which work will be undertaken until metal prices improve, the mill having been closed since October, 1930.

Burma Corp. and Mount Lyell Report Lower Ore Reserves

London, Nov. 18.—The annual report of Burma Corporation for the year ended June 30, 1931, and that of Mount Lyell Mining & Railway for the year ended Sept. 30, 1931, have been made public here. Both companies report smaller ore reserves.

. . . . At its Bawdwin mine, near Namtu, Burma, Burma Corporation reports reserves of 4,233,120 long tons, assaying 25.5 per cent lead, 15.3 per cent zinc, 0.76 per cent copper, and 20.1 oz. of silver per ton. This compares with 4,265,665 tons of virtually the same grade reported at June 30, 1930. Ore extracted during the year totaled 462,184 tons, of an average grade of 21.9 per cent lead, 11.4 per cent zinc, 1.62 per cent copper, and 19.5 oz. of silver per ton. In the preceding year, production was 500,585 tons of ore.

. . . . During the year under review, the Chinaman and Shan sections of the mine were less productive, owing to unfavorable geological conditions. Development in the Meingtha section was very satisfactory, however. In this lode no less than 277,000 long tons of ore was added to reserves. At present, work on this lode is under way on the Nos. 1, 2, 4 and 6 levels. The Meingtha orebody, at the southern end of the mine, has been opened only within the last two years.

. . . . Production of refined lead in the fiscal year was 76,520 long tons; of zinc concentrate, 52,685 tons; of copper matte, 17,274 tons; of nickel speiss, 3,449 tons; of antimonial lead, 1,555 tons; and of silver, 6,512,780 oz. The only metals of which a larger quantity was produced in the 1930-31 year than in the 1929-30 year were copper matte and antimonial lead. Net profit dropped from £693,603 after taxes and depreciation in the 1929-30 year, to £165,099 in the 1930-31 year. At the close of the year, a balance of £46,322 was carried forward, compared with £71,653 at the end of the previous year.

. . . . All three of the principal Mount Lyell orebodies at the property, near Queenstown, Tasmania, Australia, showed lower reserves on Sept. 30, 1931, than on Sept. 30, 1930. In the North Mount Lyell orebody, reserves are now put at 768,292 long tons, assaying 3 per cent copper and 1 oz. of silver per ton; in the Lyell Comstock, 730,000 tons, assaying 3 per cent copper; and in the Royal Tharsis, 2,300,000 tons, assaying 2.25 per cent copper, with a small gold-silver content. [In the previous report, North Mount Lyell showed average grade of 5.25 per cent copper, so that the cabled report putting present reserves at a 3 per cent grade would seem to be in error.—EDITOR.]

. . . . Mine output during the year ended Sept. 30, 1931, was 292,830 long tons of ore, averaging 3.77 per cent copper, compared with 244,535 tons, averaging 4.41 per cent, in the previous year. The concentrator treated 283,262 tons, from which 45,676 tons of concentrate was produced. The smelter showed an output of 10,033 long tons of copper (the highest in the company's history), compared with 9,817 tons in the previous year. Silver output was 155,976 oz., compared with 187,489, and gold output was 3,824 oz., compared with 3,631.

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Roan Casting Capacity

London, Nov. 18.—Early in November, Roan Antelope, new Rhodesian copper producer, shipped some concentrate for smelting in the United States, despite the fact that its copper smelter was put into operation in October (see p. 369 for details of output). The shipment was made because of shortage in casting capacity which did not permit the smelter to keep up with mill output of concentrate. This difficulty has since been corrected, however, and the company is now smelting its entire output in its own plant.

. . . . The first unit of the new 7,000-ton N'Kana mill of Rhokana Corporation, at N'Kana, Northern Rhodesia, is nearly ready. Rhokana was one of the stumbling blocks in the recent copper conference because the management felt that, in view of the fact that production had not started, the company should be permitted an increasing quota in the world total output.

■

St. Joe Starting Production at Atlanta (Idaho) Mine

Current stability of gold mining has caused St. Joseph Lead to go into production at its Atlanta-Rochester-Boise property in Idaho. The mine is at Atlanta, Elmore County, east of Boise, and the property will be known as the Atlanta division of St. Joseph Lead, with F. H. Skeels as manager.

The Rochester-Boise, once a producer, has been in the hands of St. Joe since 1917, but development at that and adjoining properties proved disappointing, and activities were not continued. Conditions now seem ripe for getting out what ore is available, with a staff and equipment for which there would otherwise be no work. About 103 men will be employed, starting about Dec. 1.

The old Atlanta mill has been torn down and a new 200-ton mill erected. The ore is extracted from the mine through an adit, and at the mill will be treated by amalgamation and flotation to recover the gold. Concentrate will be shipped to a smelter for reduction.

■

East Geduld Shows Profit

In October, East Geduld, new Witwatersrand producer, showed its first profit. The mill, which started work in July, crushed 45,000 tons of ore in October for a yield of 12,608 oz. of gold and an estimated profit of £5,391. Capacity is 60,000 tons of ore monthly. In August and September, absorption of gold in the plant resulted in comparatively low recoveries and small operating losses. From now on, however, East Geduld is expected to work slowly up to a monthly output of 20,000 oz. of gold.

McIntyre Porcupine Completes Surface Plant Program

McIntyre Porcupine Mines, fourth largest of Ontario's gold producers, has completed the centralization of its surface buildings and equipment in the vicinity of its No. 11 shaft at Timmins, Ont. An entirely new layout, including flotation mill, machine shops, laboratory, and combination offices and miner's change rooms, replaces the old buildings on the south side of Pearl Lake. All new surface buildings are of fireproof construction and are believed to represent the acme of modern ideas in surface mine equipment.

The miner's change house is connected with the shafthouse by a fireproof tunnel. The house itself is a large room, 120x43 ft., where miners coming off shift discard their underground clothing, enter hot and cold showers, and are conveyed by a moving platform through a solarium fitted with sun lamps to give on one trip the equivalent of three hours of sunlight. Beyond the solarium the miners coming off shift enter another change room, where individual lockers have been provided for the 800 or more underground employees of the mine. Connected with the elaborate change quarters is a similar, smaller one for surface employees, together with the assay laboratory and doctors' offices. General offices, and engineering and drafting rooms occupy the front of the building. The entire layout is recognized as among the most modern surface plants in Canada.

■

Montana Vigilantes Meet

The third meeting of the Vigilante Mining Association took place at Pony, Madison County, Mont., on Nov. 14. This also was the occasion of bringing in the line of the Montana Power Company to the Boss Tweed & Clipper gold mine. Ben H. Jackson, Three Forks, president of the association, called the meeting to order. Every seat in the hall was filled and standing room was at a premium. Senator Fred H. Whiteside delivered an economic address on "Money." Carl J. Trauerman, president of the Montana Stock & Bond Company, Butte, spoke on "Silver." Among the other speakers were Milton Leydig, manager of the Atlantic & Pacific mines, Pony; L. E. Flint, Pony; M. Stout, Manhattan; A. L. Martin, Pony; E. J. Doornbos, owner of the Josephine mine, Norris; and Mrs. E. A. Zietzke, of Whitehall. After the meeting a barbecue and dance were enjoyed by the largest crowd that has attended a celebration in Pony in many years.

■

Will Remodel Buckeye Cyanide Unit

J. W. Kager and associates are starting actual work at the Buckeye gold property, east of Jefferson City, Mont. On the property is a 75-ton cyanide plant, which the new owners will remodel and use. The property also is equipped with modern mining machinery.

U.V.X. and Shattuck Win in Tax Valuation Suits

In a decision on Nov. 5, the Arizona Supreme Court affirmed the judgment of the Yavapai County Superior Court requiring the county and state to refund to United Verde Extension, of Jerome, $192,626.78 as excess taxes paid by the company in 1929. The Supreme Court ordered that interest at 6 per cent should be paid the mining company from the date of collection, Sept. 14, 1929. In a judgment on Nov. 2, Judge John Wilson Ross of the Cochise County Superior Court fixed the valuation of the Shattuck Denn mines at Bisbee as $2,130,600, compared with $4,696,000, the value fixed by the State Tax Commission. The decision provides for a refund to the company of about $47,000.

Miami Copper filed a complaint in the federal district court on Nov. 2, alleging that the full cash value of its property did not on Jan. 1, 1931, or at any time since that date, exceed $8,845,000, whereas the current tax assessment valuation is $17,233,151.

■

Manganese Men Ask Embargo

That the American Manganese Producers' Association will resume its fight for an embargo on Russian manganese is indicated by a telegram sent to J. Carson Adkerson, president of the association, by Tasker L. Oddie, Senator from Nevada and chairman of the Committee on Mines and Mining. "I accept invitation of American Manganese Producers' Association to continue their fight and will introduce bill as soon as Congress convenes Dec. 7 to prohibit importation into United States of manganese ore and other products from the U.S.S.R. Complete shutdown of American manganese industry and serious curtailment in output of other domestic industries which have resulted from dumping into United States of Soviet products at slave labor prices are contributing greatly to present condition of unemployment," Senator Oddie wrote. "It has been and still is my contention that the United States should be absolutely independent of foreign sources of manganese supply," he added.

■

Carbonate Manganese Ore Found

Deposits of carbonate manganese ore are now being developed in the Batesville-Cushman field, Independence County, Ark. The metallic content of the ore ranges from 20 to 55 per cent Mn, and it occurs in blanket veins from 3 in. to 9 ft. thick. According to Hugh D. Miser, of the U. S. Geological Survey, who, with D. F. Hewitt, recently completed an investigation of the field, the extent of the deposits can be determined by drilling. In the past, small operators have mined oxide ores in the district, but efforts to work them on a large scale have failed because of the irregular occurrence of the oxide deposits.

The existence of the carbonate ore was first determined by Reed Denison, superintendent for Walter Denison, ore buyer and operator at Cushman, when material that appeared to be limestone was analyzed and found to be carbonate ore running 40 per cent Mn. Since then, the presence of carbonate ore has been indicated in an area 5 miles long and 2 miles wide. To date, about 2,000 tons of the carbonate has been shipped.

■

Parmelee Had Early Association With Mining Industry

Details of the career of H. C. Parmelee, whose appointment as a vice-president of the McGraw-Hill Publishing Company is mentioned in the personal pages of this issue, follow: He was born in Omaha, Neb., on Dec. 4, 1874, and educated in Omaha public schools and in the University of Nebraska. At the latter institution he pursued the chemical physical group of studies, receiving the degree of B.Sc. in 1897, and A.M. in 1899. He was undergraduate assistant in chemistry at the University for one year and graduate instructor for two years. This period was followed by several years of commercial laboratory work, first as assistant chemist for the Union Pacific Railroad Company and later as chief chemist for the Globe plant of American Smelting & Refining. Three years were spent as a consulting chemist in Denver, after which he entered editorial work, first as editor of the *Mining Reporter*, Denver, and successively as editor of the *Western Chemist and Metallurgist*, Western editor of *Chemical and Metallurgical Engineering*, and finally editor of that publication.

The years spent in editorial work were consecutive, except for an interim of one year, 1916-1917, during which he was president of the Colorado School of Mines. For several years prior to that he had been a trustee of the Colorado School of Mines. At the close of his presidency he was given the honorary degree of D.Sc. of Colorado College, Colorago Springs, Colo.

Dr. Parmelee has been editorial director of the McGraw-Hill Publishing Company since 1928; and he became a vice-presdient on Nov. 2, 1931. He is a member of Sigma Xi, Alpha Chi Sigma, Tau Beta Pi, Epsilon Chi, Phi Delta Theta, and of the following scientific and engineering societies: American Chemical Society, American Electrochemical Society, Société de Chimie Industrielle, American Institute of Chemical Engineers, Teknik Club, Denver. He is a member of the Chemsits' Club and the Engineers' Club, New York.

■

No Deal for Copper Queen

A report, current in Arizona, that Anaconda Copper might buy the Copper Queen smelter of Phelps Dodge, at Douglas, Ariz., to treat ore from Cananea, in Sonora, Mexico, is denied at Anaconda offices in New York as "ridiculous," in view of the fact that Cananea has its own smelter. It is a subsidiary of Anaconda. The Copper Queen smelter is being closed as a result of the C. & A. merger.

International Gains Tintic Acreage by New Deal

International Smelting, subsidiary of Anaconda Copper, has greatly strengthened its position in the Tintic lead-silver district by an arrangement with Chief Consolidated, whereby for $400,000 it obtains additional mining ground and a five-year contract for smelting all Chief Consolidated ores. In addition, Eureka Standard, subsidiary of Tintic Standard, is acquiring control of East Tintic Consolidated. As a result of these agreements, virtually the entire mine output of the Tintic district will be smelted in the International plant, at Tooele, Utah.

Ground acquired by International Smelting includes stock control of Eureka Bullion; a deed to Tintic Bullion, which has been under development by North Lily (International's mining subsidiary) for some time; several hundred acres to the west, north, and east of North Lily ground; and two leases on ground north of No. 1 Chief Consolidated shaft, including areas in the Eureka Mines and Plutus groups.

By drifting west on the 600 level from the Big Hill shaft, on North Lily-Knight ground, International expects to cut the Ajax limestone formation in Tintic Bullion. This formation has already been developed from the 900 level of the North Lily shaft. Eureka Bullion is already developed by workings that connect the North Lily and Big Hill shafts on the 1,200 level. A winze is now being sunk in a mineralized zone. In addition, a drift is being run from the Big Hill shaft on the 1,600 level to explore this zone.

Eureka Standard will obtain more than 500,000 shares of East Tintic Consolidated, now controlled by Chief Consolidated. The property consists of 27 claims in two groups. One group has been prospected by a drift from the 1,300 level of the Eureka Standard. The other, adjoining Tintic Standard, has been developed from the No. 1 shaft on the 1,000 level. Development will be continued in both groups, according to James W. Wade, general manager.

■

Kildun to Sink New Shaft

A new five-compartment shaft will be sunk at the Kildun Mining property, in the Matehuala district, San Luis Potosi. The new shaft will be to the east of the present workings, which are in the western section of the property, adjoining Santa Maria de la Paz. The company has developed two silver veins south of its present shaft, and work to the east has disclosed a gold vein that branches off from the main silver vein to the northeast. By acquiring additional ground east of its original holdings, the company has been able to protect the extension of this vein. Shipments of gold ore are being made to the San Luis Potosi smelter of A.S.&R. In the six months ended Aug. 31, they netted $136,579. The shipments will be continued at the rate of three carloads daily, and the company hopes that proceeds will be sufficient to cover the cost of shaft sinking. J. A. Williams is president of the company.

MARKET AND FINANCIAL NEWS

Silver Experts Advocate Selling Agreement

An international silver selling agreement among groups and agencies which control the major stocks and production of the metal is proposed in a report by the Committee of Experts of the International Chamber of Commerce, made public in Washington, Nov. 9, by Silas H. Strawn, chairman of the American Chamber's silver committee. In making the report public, Mr. Strawn announced that negotiations to make effective the proposals of the experts are now going forward.

The experts, who included Ernest Franklin, of Samuel Montagu & Company, London; E. D. Van Walree, of Bernn, Holland; and Marshall W. Tuthill, of Tuthill & Company, New York, advance four recommendations for alleviating the silver situation. Broadly speaking, the recommendations are predicated upon the likelihood that neither an international conference on silver nor governmental action to monetize the metal will take place in the immediate future.

The first recommendation, proposing an international selling agreement, the experts believe, can be carried into effect within a reasonable time. The second and third recommendations, relating to the monetization of silver, can be studied at leisure and action taken at some future time, in the opinion of the experts. The fourth proposal, the experts specify, is a recommendation to those parties which are interested in the sale of silver as an industrial product.

The recommendations of the silver experts, in part, follow:

"Of the total annual production of silver, estimated for this year at less than 200,000,000 oz., the larger proportion is at present controlled by a few corporations in America who, if they had a working agreement with the Indian treasury, giving all participants a reasonable quota of world sales, should be capable of keeping silver at a price fair to both buyers and sellers so long as they supply the market with judgment. It is not generally realized that, at the present price, the value of a year's production of silver is only about $56,000,000.

"The annual demand for silver includes about 50,000,000 ounces for industrial consumption. We may take it that this would be bought almost irrespective of price. There remain, therefore, the Indian and the China demands The former has remained steady for the last three years and does not depend entirely on the price. The difficulty is with China, but if due attention is paid to the position in that country, this difficulty should not be unsurmountable.

"Your committee, accordingly, recommends that if the International Chamber of Commerce wishes to retain the subject of silver on its agenda, it should investigate the possibilities of bringing the North American producers and refiners of silver into a sales agreement with the government of India. For this purpose of course the producers of the United States, in order to conform to their national laws, could only be organized from the point of view of export sales. Other producers of any substantial quantity should naturally be welcomed into the agreement, whilst the importance of bringing the Bank of Spain and kindred institutions into these deliberations should not be lost sight of. A selling agreement in the silver market that does not include the Indian Government would not be practicable.

"The committee also recommends that those interested in the sale of silver might with advantage emulate the example set in other industries, by the establishment of research institutes for the purpose of devising new uses and expanding present uses of the product. In the case of silver, a considerable improvement in the industrial demand would immediately follow the discovery of a satisfactory process which would eliminate the tendency of that metal to tarnish. The committee also calls attention to the unreasonably wide margin which exists between the wholesale price of silver and the retail price of the articles manufactured from silver, after making ample allowance for labor costs."

The experts were named by the Council of the International Chamber in pursuance of a resolution adopted at the Washington meeting last spring. They were asked to report on the practicability of immediate international action with a view to influencing the production, sale, or price of silver.

Quarterly Reports

NEW JERSEY ZINC, operating zinc mines in New Jersey, Virginia, and Colorado, reports net income of $778,817 in the third quarter of 1931. This compares with $860,769 in the first quarter and $865,252 in the second. All charges have been deducted in arriving at these figures. The company is maintaining dividends of 50c. quarterly.

INTERNATIONAL NICKEL, operating nickel-copper properties in Canada, reports net profit, after all charges, of $645,970 in the third quarter of 1931, compared with $1,700,249 in the second quarter. Operating profit was $2,030,991. The balance sheet on Sept. 30 showed current assets of $29,925,461, compared with $37,245,883 at the beginning of the year. The surplus on Sept. 30 was $16,881,605.

NEVADA CONSOLIDATED, copper producer operating in Nevada, Arizona, and New Mexico, reports a loss of $1,323,564 before depreciation in the third quarter of 1931. Actual operating loss was about $160,000, but as the management reduced the price of the entire inventory of unsold copper from 10½c. to 7c. a pound, the net loss was much greater. In the second quarter, Nevada reported an operating loss of $19,382. Production in the third quarter was 32,389,553 lb. of copper.

CALLAHAN ZINC-LEAD, operating in Idaho, reports a deficit of $15,031 in the third quarter of 1931. There was no production, work being restricted to some underground drilling.

BUNKER HILL & SULLIVAN, lead producer, of Idaho, reports a profit, before depreciation, of $140,664 in September, 1931, compared with $231,419 in the previous year. For the nine months ended Sept. 30, the company reports a total profit of $1,037,034.

HECLA MINING, lead producer, of Idaho, reports net profit, after depreciation and taxes, of $144,305 in the third quarter of 1931, compared with $97,340 in the second. Production was 12,150,113 lb. of lead from 57,157 tons of ore. Silver output was 322,089 oz. and zinc output, 183,332 lb.

MCINTYRE PORCUPINE MINES, gold producer, of Ontario, reports net income of $543,598 in the quarter ended Sept. 30. This is after tax deductions but before depreciation. Production was $1,277,222 and operating profit $585,692.

DOME MINES, gold producer, of Ontario, reports net income after taxes, but before depreciation, of $424,098 in the quarter ended Sept. 30. This includes $62,642 of non-operating income. Production was $889,145. A total of 136,850 tons was milled, yielding an average of $6.50 a ton.

Lake Shore Reports Record Profits in 1930-1931

Lake Shore Mines, now the largest gold producer on the American continents, reports that its mine, at Kirkland Lake, Ont., produced $9,152,935 in gold bullion during the year ended June 30, 1931, and that the net profit, after all charges, was $4,505,601. These figures compare with output of $6,576,780 and net of $3,128,985 in the preceding fiscal year. The company paid out $3,600,000 in dividends during the fiscal year, bringing total disbursements since operations started up to $13,020,000. Capitalization is $2,000,000.

Total assets of Lake Shore are put at $5,254,619, of which $3,051,827 represents current assets. The company has completely written off the value of its mine by depletion allowances, and the property is valued at $1. Current liabilities are $871,454. Operating costs during the fiscal year were $5.161 per ton, compared with $5.852 in the previous year. The production was obtained from 698,624 tons of ore, indicating an average yield of slightly over $13 a ton.

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Teck-Hughes' Fiscal Year Good

In the fiscal year ended Aug. 31, Teck-Hughes Gold, third largest gold producer in Canada, reported a net profit, after tax provision and depreciation, of $3,311,591, compared with $3,051,886 earned in the previous fiscal year. Production was $5,973,120, compared with $5,415,970, and operating profit, before tax provision, was $3,649,958. The company reported current assets of $2,707,385 at the end of the year, including $2,123,446. Current liabilities were only $657,964. Production was 396,200 tons, which yielded $15.08 a ton, compared with 340,675 tons, yielding $15.90 a ton, in the previous year. Dividends paid totaled $2,876,786.

■

Malaya Buys Tin Excess

The Malayan government has purchased 3,500 tons of tin, all excess production above the quota agreement. The metal bought is entirely independent of the holdings of the International Tin Pool, according to an official statement made in London recently. Malayan exports, under the agreement, have been reduced to 40 per cent so as to bring supplies from that territory down to the quota fixed earlier in the year.

■

Higher Antimony Tariff Asked

The Tariff Commission has received an application from the Texas Mining & Smelting Company, Laredo, Tex., for a higher duty on antimony oxide and antimony regulus or metal. The metal at present is assessed at the rate of 2c. per pound.

Financial Notes

HOLLINGER CONSOLIDATED, gold producer, of Ontario, reports declaration of its regular dividend of 5c. and an extra of 5c., payable on Dec. 2. The extra dividend will represent profits made by the company through the premium on gold output that has resulted from depreciation in Canadian exchange. Hollinger pays its dividends in Canadian funds.

GLYNN'S LYDENBURG, gold producer, of Transvaal, South Africa, reports a loss of £876 in the year ended July 31, 1931, compared with a profit of £4,341 in the previous year. Output was £111,750 in gold from 74,500 tons of ore. Working costs were 29s. 4d. a ton.

BROKEN HILL PROPRIETARY, iron and lead producer, of New South Wales, Australia, reports a net profit of £83,257 in the year ended May 31. Operating profit was £324,751. The value of output was £2,358,868. The balance sheet shows total assets of £8,290,885. No dividends were paid.

KILDUN MINING, gold-silver producer, of San Luis Potosi, Mexico, reports total assets of $907,230 on Aug. 31, 1931, of which $148,681 represents cash. During the six months covered by the reports, the company netted $136,579 from ore sales.

ALASKA JUNEAU in October, 1931, mined and trammed to mill 336,660 tons, from which was obtained operating revenue of $298,500, or 88.67c. per ton; operating expenses, $175,000, or 51.98c. per ton; operating profit, $123,500, or 36.69c. per ton; and other expense, less interest received, totaled $5,300, leaving $118,200 to surplus for the month.

BENGUET MINING, gold producer of the Philippine Islands, reports net profit in the first six months of 1931 of 853,609 pesos, compared with 959,026 pesos in the corresponding period of 1930. Production was 1,536,924 pesos and, in addition, the company received 379,733 pesos in interest and dividends (largely Balatoc Mining).

Failure of Copper Conference Startles Trade—Price Shows Weakness

New York, Nov. 19, 1931.—The conference of copper producers on general curtailment of output came to an unexpected end. Though most producers seemed to hold out some hope that the negotiations may again be resumed in the near future, the meetings which terminated with the afternoon session on Nov. 17 ended in complete failure. The news surprised all in intimate touch with the copper market, and yesterday trading interest almost disappeared, especially after it became known that London prices broke sharply as soon as the news reached Europe. The market here was weak, and the metal was offered in more than one direction at 6¾c., delivered Connecticut basis. The unfavorable developments in copper depressed the entire metal market. Silver suffered a severe break early in the week on the very first attempt by speculators to take in some of their paper profits. Lead, zinc, and tin showed little change, with business quiet. Quicksilver was weak on reports of sales by Mercurio Europeo to American consumers.

Copper Offered at 6¾c.

After three weeks of active negotiation for a settlement of the world's copper difficulties, the meetings of leading foreign and domestic producers came to an end on what the trade is inclined to view as a disagreement between African producers — Katanga and Rhokana. The latter, according to reports, was dissatisfied with its production quota for 1932, especially since this company will enter the ranks of producers early next year. Rhokana, one of the new African producers, under direction of Rio Tinto, has been equipped to produce about 7,000 tons of copper a month. Operation will probably start next February. The leading American and Canadian producers, though not entirely satisfied with the quota arrangement under the proposed plan, were, according to those in touch with the conference, ready to agree to the terms laid down.

As late as 4 p.m. on Nov. 17, operators in copper felt confident that an agreement would be reached. At 5.20 p.m., however, the meeting broke up and the Belgian and British delegates prepared to leave for home.

Yesterday, both the foreign and domestic market went flat, and for the greater part of the day prices were little more than nominal. Custom smelters offered the metal freely at 6.75c., Connecticut, but buyers appeared so frightened over the developments in the market that it was almost impossible to draw a bid on any quantity business.

Through all the negotiating, however, nothing has occurred to change the status of Copper Exporters, Inc. This agency continued to quote 7½c., c.i.f. European ports. Foreign demand was good up to Nov. 17 and sales since Nov. 1 totaled 20,500 short tons.

The copper statistics for October were not given out on Nov. 12, owing to the absence of communications from some producers but refined stocks are said to have increased 18,000 tons. Some producers believe that the market can be

served to better advantage by keeping the statistics from the public.

Lead Unsettled

Lead sold in good volume during the week ended Nov. 11, but was quiet last week. On Nov. 9 the American Smelting & Refining Company raised its contract price from 3.85c. to 3.95c. New York. The St. Louis market moved up 10 points to 3.75c. On the following day the New York quotation was raised another 10 points, establishing the price of 4.05c. In St. Louis, however, the price was advanced 15 points on Nov. 10, to the basis of 3.90c.

Today, Nov. 19, the New York price was lowered to 3.95c.; St. Louis dropped to 3.80c.

Lead refinery statistics for September and October, in tons, follow:

U. S. Lead Refinery Statistics (*a*)

Production:	September	October
Domestic ore	31,966	36,546
Secondary and foreign	3,934	4,722
Totals	35,900	41,268
Stock at beginning	134,977	132,804
Total supply	170,877	174,072
Stock at end	132,804	139,796
Shipments by difference	38,073	34,276
Shipments reported	38,059	34,276

(*a*) Accounts for refineries at Omaha, Selby, Perth Amboy, Carteret, Collinsville, East Chicago, Herculaneum, Grasselli, Federal, Galena, Newark, Matawan, Joplin and Ontario. (*b*) Does not include stocks of refined lead produced from ore or base bullion of foreign origin.

Little Change in Zinc

Demand for zinc was quiet, but prices were fairly steady and moved within narrow limits. Most of the business booked was in near-by material on the basis of 3.30c. per pound, St. Louis. Yesterday, on the unsettlement in copper, some sellers appeared to waver a little, and a moderate tonnage of prompt zinc was offered in more than one direction at 3.25c.

Zinc statistics for September and October, in tons, follow:

	September	October
Production	21,356	21,674
Daily rate	712	699
Shipments	20,902	21,163
Stock end of month	130,155	130,666
Unfilled orders	15,388	18,365
Retorts operating end of month	22,817	23,774
Retorts, average for month	22,152	22,209

Note: There were no export shipments during September and October.

Tin Neglected

Prices of tin during the period were almost entirely nominal, and were set by importers' offers rather than by consumers' bids. Prices continued at around 23c. for prompt Straits, with the usual premiums of about 15 points per month for future delivery. Another meeting of tin producers will be held next week, at which a further curtailment may be considered.

Silver Sharply Lower

After touching 37¼c. per ounce on Nov. 11, the highest price quoted since May 31, 1930, the silver market declined sharply during the past week and closed easy on Nov. 18 at 29¾c. The decline was caused by selling and heavy offerings from abroad in an unwilling market.

Production of silver, in thousands of ounces, by countries, for August, September, and October, follows:

	Aug.	Sept.	Oct.
United States	2,419	2,101	2,211
Canada (*a*)	1,610	1,403	2,117
Mexico	6,814	(*c*)	(*c*)
Peru (*b*)	795	562	607
Australia	545	454	379
Burma	460	460	(*c*)

(*a*) Incomplete: silver contained in blister copper and lead bullion exported is omitted. (*b*) Partly estimated. (*c*) Not yet available.

Sterling Exchange, 90-Day

Sterling Exchange, 90-day demand: Nov. 5th, $3.73½; 6th, $3.76¾; 7th, $3.78½; 9th, $3.76; 10th, $3.81; 11th, $3.79; Nov. 12th, 3.77¾; 13th and 14th, 3.75; 16th, 3.76; 17th, 3.77½; 18th, 3.75½.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices, and at present are largely nominal in view of erratic sterling exchange.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £95, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 6.875c.; futures, 6.625c. Cookson's "C" grade, spot, 11½c. "CMC" grade, 99.9 per cent, spot, 11c.

BERYLLIUM—See Alloys.

BISMUTH—Per lb., in ton lots, $1.15. London, 6s. 4d., nominal.

CADMIUM—Per lb., 55c. London, 2s. 2d.@2s. 3d. Nominal.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron. (Usually sold as ferrochrome.)

COBALT—Per lb.: Metal imported from Belgium, 97@99 per cent, $2.50 less 35 per cent for cash. On yearly requirements, usual rebate of 5 to 10 per cent, as to quantity. London quotes $3.75 per kilo, subject to usual discounts.

INDIUM—Per oz., 98½ per cent, $90@$100 per oz. Nominal.

IRIDIUM—Per oz., $90@$100 for 98@99 per cent sponge and powder. London, £22@£24. Nominal.

LITHIUM—Per lb., 98@99 per cent, 100-lb. lots, $15.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 30c. in carloads; 32c. in 100 lb. lots or more, l.c.l.; ⅜, ½, 1, and 2 lb. sticks, 5c. per lb. over ingot price; ⅛ and ¼ lb. sticks, 8c. per lb. extra.

MANGANESE—Per lb., 95@97 per cent, 42c. (Usually sold as ferromanganese.)

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9; 97 per cent, $4.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £225 to £230, with prices nominal owing to the unsettlement in exchange.

OSMIUM—Per oz., $65@$70. London, £16 to £18.

PALLADIUM—Per oz., $19@$21. London, £4 10s., nominal.

PLATINUM—Per oz. Official price of leading interest $40. Cash transactions between dealers and refiners several dollars less. London market nominal at £10 to £10 6s. The average price of Colombian crude platinum, basis 85 per cent platinum, for October was $28, against $27 in September.

QUICKSILVER — Per 76-lb. flask, $68@$70. The market was quiet and unsettled on reports of the sale of a large quantity by Mercurio Europeo to an American electrical company.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $50@$55.

RUTHENIUM — Per oz., $50@$65. London, £9 10s. Nominal.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powered, $1.45.

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s. 6d. for 60 to 65 per cent sulphide ore.

BERYLLIUM ORE—Per ton, minimum 10 per cent BeO, $20@$30, f.o.b. mines. Export, small lots, $20@$60.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17.50 for 46@48 per cent Cr_2O_3 ore, and $19.50@$20 for 50@51 per cent ore. London, 80s. for 48 per cent Rhodesian.

COBALT ORE—Per lb. of Co, 12 to 14 per cent grade, 50c., f.o.b. cars, Ontario. Market nominal.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron. $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Daily Prices of Metals

Nov.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
5	6.775	22.35	3.85	3.65	3.15@3.20
6	6.775	22.875	3.85	3.65	3.15@3.25
7	6.775	23.05	3.85	3.65	3.175@3.30
9	6.775	23.15@23.40	3.95	3.75@3.825	3.20@3.25
10	6.775	23.55	4.05	3.90	3.25
11	6.775	23.125	4.05	3.90	3.25
Av'ge	6.775	23.038	3.933	3.756	3.223
12	6.775	23.125	4.05	3.90	3.25@3.30
13	6.775	23.00	4.05	3.90	3.30
14	6.775	23.125	4.05	3.90	3.30
16	6.775	23.25	4.05	3.90	3.30
17	6.775	22.75	4.05	3.90	3.30
18	6.525	22.75	4.05	3.90	3.25
Av'ge	6.733	23.00	4.050	3.900	3.288

Average prices for calendar week ended November 7, 1931, are: Copper, 6.775c.; Straits tin, 22.545c.; New York lead, 3.850c.; St. Louis lead, 3.650c.; Zinc, 3.183c.; Silver, 32.675c.

Average prices for calendar week ended November 14, 1931, are: Copper, 6.775c.; Straits tin, 23.200c.; New York lead, 4.033c.; St. Louis lead, 3.881c.; Zinc, 3.267c.; Silver, 35.917.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.25c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold and Sterling Exchange

Nov.	Sterling Exchange "Checks"	Silver		Gold, London	Nov.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
5	$3.74	32¾	19 9/16	110s 3d	12	$3.78¼	36¼	21 7/16	109s 3d
6	3.77	34	20 5/16	109s 4d	13	3.75½	35⅜	21⅛	109s ...
7	3.79½	34⅜	20	.....	14	3.75½	35½	21 9/16	.....
9	3.76¼	35¾	21 1/16	109s 3d	16	3.76¼	32⅝	18	109s 2d
10	3.81½	37¼	21 9/16	108s 9d	17	3.78	31⅛	18⅞	108s 6d
11	3.79½	35⅜	20¾	109s ..	18	3.76½	29¾	18 4/16	108s 9d

Average for week ended November 11: Silver, 34.917c.; Sterling exchange, $3.78000.

Average for week ended November 18: Silver, 33.438c.; Sterling exchange, $3.76667.

New York quotations are as reported by Handy & Herman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables commanded one-half cent premium at noon on Nov. 18.

London

Nov.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic (Bid)						
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
5	36⅜	37⅜	42½	128⅝	130⅜	13⅞	13 13/16	13⅜	13 13/16
6	37⅜	37 15/16	42½	130	132½	14½	14 9/16	13¾	14 3/16
9	38½	39½	43½	132⅜	134⅜	15	15	14½	14½
10	39⅛	39⅜	43½	134½	136½	15 1/16	15	14 3/16	14⅝
11	36⅞	37⅜	41	132	134	14⅞	14 13/16	13 13/16	14¼
12	37 9/16	37 13/16	41½	132¾	134¾	14⅝	14⅝	13¾	14½
13	37⅜	38	43	133	135⅛	14 15/16	14 13/16	14 1/16	14 7/16
16	38 5/16	38⅞	43	134½	136½	15 1/16	15 1/16	14	14⅜
17	37⅝	38½	43	134½	136½	14 13/16	14 13/16	14 3/16	14⅝
18	35⅝	36⅝	41	131⅞	133⅞	14⅝	14⅝	14	14⅝

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Eastern ores, cents per long ton unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per long ton unit:

North African and Swedish, low-phosphorus, 8½@9½c.

Spanish and North African, basic, 50@60 per cent, 8½@9c.

Swedish foundry or basic, 65@68 per cent, 9c.

Newfoundland foundry, 55 per cent iron, 8½c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 23c.; Chilean, 47 per cent minimum, 29c.; Indian, 48@50 per cent, 25@26c.; Caucasian, 52@55 per cent, 26c.; South African, 52@54 per cent, 23@25c.; 50 to 52 per cent, 22@24c.; 44 to 46 per cent, 21½c.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $50 in carloads, to $60 barreled. Javan or Caucasian, 85 per cent minimum, $50@$60. Domestic, 70 to 72 per cent, $43@$50 in carloads, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 45c., delivered Pittsburgh, for 75@85 per cent concentrate. London, per long ton unit, nominal at 37s. 6d. to 42s. 6d. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb., Ta_2O_5, 70c. for 60 per cent ore. Market nominal.

TIN ORE — No market in United States. London market wholly nominal owing to exchange situation.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Chinese wolframite, $11@$11.25, duty paid. Bolivian scheelite, $10.50. Domestic, $9.50 to $10.50.

VANADIUM ORE—Per lb. V_2O_5 contained, 27c., f.o.b. shipping point. London, prices withdrawn temporarily.

ZIRCON ORE—Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and and seller.

Tons of 2,000 lb. unless otherwise noted.

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent Li_2O, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $400@$450; crude No. 2, $200@$250; spinning fibers, $90@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $27.50@$35; cement stock, $15@$20; floats, $10@$12.

Per ton c.i.f. New York: Rhodesian crude No. 1, $300; No. 2, $200. Nominal.

Per ton, c.i.f. New York: Russian crude No. 1, $225; No. 2, $175; No. 3, $125. Nominal.

Per ton, f.o.b. mines, Vermont: Shingle stock, $45; paper stock, $35; cement stock, $20.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent 300 mesh, $42; 100 mesh, $39.

BARYTES—F.o.b. mines:

California: Crude, $7 per ton.

Georgia: Barytes ore, crude, $6@$6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6; 1 per cent iron and 93 per cent $BaSO_4$, $5.50, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@$12.25, f.o.b. *Arkansas* mines: abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$6.50; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $5.50@$7.

BENTONITE—Per ton, carload lots, f.o.b. *Wyoming* mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $5; crushed air-floated, $7; pulverized, $9.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Delaware, No. 1, $14.50.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

DIATOMITE—Per ton, f.o.b. *Nevada*, crude, dried, in bags, $10; minus 40 mesh, $15; 300 mesh, $20; high temperature insulation, $30.

EMERY—Per ton, f.o.b. *New York*, domestic crude ore, first grade, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30@$35. F.o.b. *Pennsylvania*, in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina*, potash feldspar, 200 mesh, white, $15, in bulk; soda feldspar, $18. F.o.b. *Maine*, potash feldspar, white, 200 mesh, $19, in bulk. Granular glasspar, white, 20 mesh, f.o.b. *North Carolina*, $10.50 in bulk.

Virginia, No. 1, 325 mesh, $17; 200 mesh, $15@$16; 160 mesh, $14@$15; No. 1 glassmakers', $11; enamelers', $12.50.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, bulk basis, $13. Foundry lump, 85-5, $15. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $30 in bulk; $34 in bags or barrels. *Colorado* mines, 82-5, $10.

Foreign fluorspar, gravel, 85-5, $18.50 per gross ton, duty paid.

FULLER'S EARTH — Per ton, f.o.b. *Colorado*, $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida*, 30 to 60 mesh, $16; 15 to 30, $15; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines; concentrate, $40; washed grades, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. *Colorado:*

Brilliant black, $32.90; seconds (mine run), $25.50.

Selects, $30.50, f.o.b. Utah. Nominal.

GRAPHITE—Per lb., f.o.b. *New York*: Ceylon lump, 6½@7½c.; carbon lump, 3@6c.; chip, 5@6c.; dust, 3@4c.; Madagascar flake, 5@6c.

No. 1 flake, 8@16c.; No. 2, 5½c. upward; fine ground, 55 to 70 per cent carbon, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa*, $2.50; *Ohio* and *New York*, $3. Ground, *Ohio*, $4; *Iowa*, $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

KIESELGUHR—See Diatomite.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California*, dead-burned, $25. Kiln run, 93 per cent MgO (artificial periclase), $68; 88 per cent MgO, $35. Caustic, 95 per cent MgO, $45; 90 per cent, $40. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico*, scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire*, roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina*: Punch, 3@5c.; 1½x2 in., 20@30c.; 2x2, 30@50c.; 2x3, 60@90c.; 3x3, $1@$1.40; 3x4, $1.40@$1.80; 3x5, $1.50@$2; 4x6, $2.25@$3; 6x8, $2.50@$3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale)—Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia*.

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $22 in barrels. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia*, dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per net ton, bags extra.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13c.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

[1]QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical and optical use command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. *Illinois:* 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey: Soapstone, ground, $10@$12.

New York: Double air floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $4.60@$8.25; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £23 for Cornish white. Mexican, not quoted openly, owing to exchange situation.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black oxide, 70@71 per cent grade, $1.35.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 3.40c. for either large or small crystals.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $1.77.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $16@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45. Grecian refractory ore, 37@42 per cent, 40c. per unit.

FIRECLAY BRICK — Per M., first quality, $40, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania*, $40: *Alabama*, $50@$51; *Illinois* and *Indiana*, $49.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 16½c.; wire, f.o.b. mill, 9c.

LEAD SHEETS—Per lb., full rolled, 7c.; clipped, 7¼c.

MONEL METAL—Per lb., sheets, full finished, 42c.; strip, cold-rolled, 45c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 12¼c.; plates, 15½c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 19⅞@20¼c.; 18 per cent, 23⅜@23¾c. Wire and rods, 10 per cent, 23⅜c.; 15 per cent, 27⅜c.; 18 per cent, 30⅞c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 25⅜c.; wire, 5 per cent, 25⅞c.; 10 per cent, 30⅜c.

ZINC SHEETS—Per lb., 9c., f.o.b. works; ribbon, 8½c.; 7 per cent discount on orders for 18 tons or more.

Alloys

BERYLLIUM—Per lb. of contained Be, $50, chiefly sold as an alloy of 12 per cent Be and 88 per cent Cu.

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, spot, 17½c.; maximum 0.10 per cent carbon, 26c., spot; 24½c. contracts.

FERROMANGANESE — Per gross ton furnace: domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per gross ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $31, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant, carlots.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1@$1.10, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $105 for maximum 2½ per cent carbon; $115 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $16.50; basic, $15@$15.50; and No. 2 foundry, $16@$16.50.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $29; bars, plates, and structural shapes, per 100 lb., $1.60.

COKE—Per ton, Connellsville furnace, $2.40@$2.50. Connellsville foundry, $3.25@$4.50. Birmingham furnace, $3.50@$4.50. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham foundry, $5.

[1]Price furnished by Foote Mineral Company, Philadelphia.